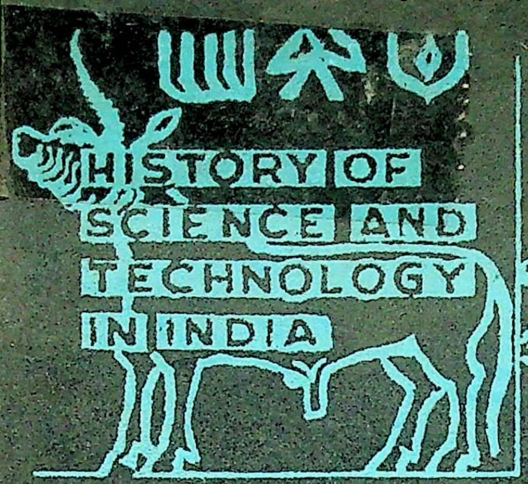
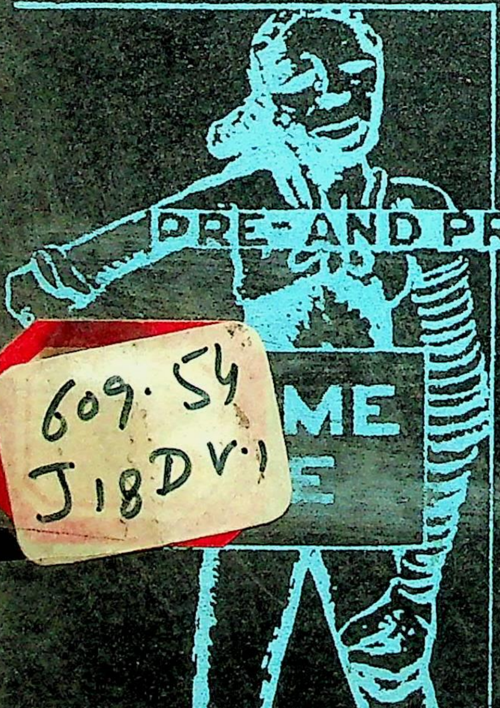


O.P. JAGGI

DAWN OF INDIAN TECHNOLOGY



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HISTORY OF SCIENCE
AND TECHNOLOGY IN INDIA

VOL. I

DAWN OF INDIAN TECHNOLOGY

BY THE SAME AUTHOR

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AND TECHNOLOGY IN INDIA

VOL. ONE

DAWN OF INDIAN TECHNOLOGY

(PRE- AND PROTO-HISTORIC PERIOD)

ILLUSTRATED

by

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FOREWORD

by

Prof. D. S. KOTHARI

Chairman
University Grants Commission
New Delhi

1969

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इदं नम ऋषिभ्यः पूर्वजेभ्यः पूर्वेभ्यः पथिकृद्भ्यः
To the seers, our ancestors, the first path-makers.
(*Rigveda X. 14. 25*)

Foreword

by

Prof. D. S. KOTHARI

Chairman, UNIVERSITY GRANTS COMMISSION

NEW DELHI-1

The *HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA* by Dr. O.P. Jaggi is a welcome and valuable addition to the relatively meagre literature on the subject. I believe the book would be of interest to a wide circle of readers.

There is now an increasing, and deepening interest in the history of Indian science and technical inventions, extending over a very long period of time. To some extent this has been stimulated by Professor J. Needham's monumental work on Chinese science. (This work contains several interesting and highly suggestive references to India's contributions.) For a proper understanding of the social and political history of a country, a knowledge of the history of science and technology is of the utmost importance. Again, there has always been an active inter-action and cross-fertilization between scientific and technical developments in different parts of the world : the flow of ideas and discoveries cuts across all barriers. Much has been written about the history of Western ancient and medieval science, and yet in a true sense the history of Western science will remain *incomplete* without an adequate knowledge of the growth of science in the East, and India specially.

I hope Dr. Jaggi's present work will contribute significantly towards a more sustained study and research so that at not too distant a future, we have a much fuller, documented and integrated account of the major events and trends in the history of science and technology in India.

April 26, 1969.

Preface

The words Science and Technology may be relatively modern ones, yet what they actually mean, *viz.*, the knowledge and understanding of natural phenomena and their application, has not been the possession of the modern man only. They are as old as mankind itself. In our current enthusiasm, we are liable to forget that most of the fundamental scientific discoveries and their application belongs to the prehistoric past. Discovery of the use of a stick or a stone to chase away or to catch and kill an animal, to make and use tools and weapons of stone, wood and bone, to make fire and utilize it for various purposes, are the discoveries certainly more significant than even those of the modern times. Discovery that the food could be deliberately produced also, and turning over of the human society from the stage of mere food-gathering to that of food-producing one, was a technical development of which all else that followed is the consequence. It transformed our planet for all times to come. Availability of unlimited supply of the food materials made it possible for man to increase in numbers and to inhabit vast areas of the earth in small and large communities which led to the creation of villages, towns and cities.

Discovery of the use of the wheel for making a variety of pottery objects as also of the wheeled vehicles for transport, and domestication of animals, made man's life comparatively comfortable. Later he discovered the useful potentialities of the different kinds of 'stones' that could even be melted and re-shaped. Extraction of various metals such as copper, tin, etc. from such 'stones' and making of a variety of metallic implements, weapons, household utensils and other things changed vastly the environments of man.

All these scientific developments are so significant and yet they look so common-place to us today that one sometimes takes them for granted.

Study of these scientific and technological aspects of the development of prehistoric communities and societies of any part of the world is useful, important and relevant to our present age of scientific progress as it forms the foundations of which all else that followed is the super-structure. This applies much more so to the Indian sub-continent.

No doubt we are far removed from those societies in time and environments, yet we cannot deny that we have evolved out of them. They were our

ancestors and we have inherited their characteristics—their mode of thinking, their strong points and achievements as also their weaknesses and failures. Knowledge of our own development through the ages is thus not a mere curiosity or even education but it equips us better to face the future. It can be conducive to our future growth as well.

Present study is not confined to the political boundaries of India as they exist to-day but takes the Indian sub-continent as a whole. No present-day boundaries existed then and the development involved the region as a whole. A contrary approach is neither feasible nor possible as that would vitiate the correct picture of that ancient period.

By definition History is the story of mankind gathered from sources available in writing while Prehistory pertains to an earlier period for which no written records are available. These definitions when applied to Indian conditions might land us into difficulties. Where are we to place the Harappān civilization whose people were literate, as is shown by their writings on stone seals, but which we are not yet literate enough to decipher? So, a new term namely Proto-history, which comes after prehistory but before history, has been used for this period.

I acknowledge with thanks the help extended to me by the Director General of the Archaeological Survey of India, New Delhi, in supplying me with more than two dozen of the relevant photographs that have been incorporated in this volume. I am grateful to the publishers Messrs. Atma Ram & Sons and the printers Raisina Printery for their unstinted co-operation and the efforts they put in to bring out this book.

April, 1969 *O. P. J.*

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PART ONE

1

Prehistoric Man—His Life and Times

HISTORICAL

Man has lived on this planet for more than a million years (perhaps even much longer) and yet this fact was not known to us till just about a hundred years from now. In the East, the people, particularly the Hindus, believed—as they believe about their other religious matters—that man existed on the earth since countless ages. In the West, according to the story of Adam and Eve, the total age of man and also of the earth, was just about a few thousand years. According to Archbishop Ussher's chronology,[1] the first man was created in 4004 B.C. on March 23rd. Discovery of the remains of long-extinct animals from various parts of Europe however, led to modification of the above belief. Thereafter it was held that there had been several periods of creation and man belonged to the last of them all.

One of the greatest upheavals witnessed during the last century was at the time when Darwin published his treatise, "Origin of the Species" in 1859. In it he said—and rightly so—that man evolved out of his ape-like ancestors. For this 'sacrilege', Darwin was caricatured by some people with his 'ape-like ancestors'. He lost much of his medical practice but somehow his life was spared, which privilege was not granted to the earlier so-called heretics.

Strangely, while Darwin's book caused a great upheaval, another equally significant observation on the same theme but in another branch of knowledge, went almost totally unnoticed. This was the finding of peculiarly cut-and-shaped stones alongwith long-extinct animal fossils in 1847 by Boucher de Perthes in

the old terrace deposits of the river Somme at Abbeville in France. Such stones had been seen earlier also but they had gone unrecognized. Perthes boldly claimed that these stone objects were made and used as tools by man who lived in very ancient times. Later in 1859, three eminent English geologists Prestwich, Evans and Falconer, confirmed Perthes' claim. In 1863 Lyell published his work, "Geological Evidence of the Antiquity of Man".[2]

Pioneering work of these scholars created a tremendous amount of curiosity and enthusiasm amongst scientists to know, "When, Where and How" the prehistoric man lived. Various disciplines of knowledge helped in this direction, amongst whom archaeology and geology stand uppermost.

GEOLOGY REVEALS MAN'S ANTIQUITY

Let us see how geology *i.e.* the science of the earth's crust, its strata and their relations and changes, helped in establishing antiquity of the prehistoric man.

Geologically, our earth passed through different periods in its life. From its birth to infancy, childhood, adulthood and its present stage, it went through four periods : (1) Primary (2) Secondary (3) Tertiary and (4) Quaternary. Each of these is further divided into different sub-phases. To us it is only the last period, the Quaternary which is of interest because so far as we know, it is during this period that man emerged. This period has two sub-phases namely, Pleistocene and Holocene.

Pleistocene (literally meaning most recent) sub-phase is demarcated from the earlier period by the fact that the earliest man, the true oxen horses and the elephants appeared on the earth at the beginning of this time. During this period large parts of the earth were repeatedly covered and uncovered by snow for thousands of years ; the time of snow being called as glacial periods and the interspersed time of relatively warmer temperature when the snow melted as interglacials. There were in all four glacial and three interglacial periods.

Holocene (literally meaning recent) sub-phase of Quaternary

period began after Pleistocene and it is demarcated from the latter by full and complete extinction or disappearance of some of the earlier species of animals and the appearance of the evidence of domestication of dog, sheep and cattle. Holocene is the phase in which we are living now.

Study of glaciers, the glacial and interglacial periods and the river beds of the Pleistocene phase tell us of the whereabouts of the prehistoric man. Let us see how.

A glacier, as we know, is a very slowly moving river of snow. Snow on the summits of the mountains moves down the valleys by gravity. It collects tributaries as it goes along. In moving down it exerts tremendous pressure on the sides of the valleys which get worn smooth by the slowly moving mass of compact snow, grinding into the rocks. Huge piles of splintered rocks called moraines—lateral, medial and terminal ones, lie along the course of these moving glaciers. When the glaciers melt, these moraines remain there. It is they that betray the course of the past glacier or glaciers and the duration of different glacial and interglacial periods. In turn, it helps us to fix the time limits of other contemporary events.

Besides that, different glacial and interglacial periods affected the level of water in the seas and the rivers. During the interglacial periods thousands of feet of snow melted on the mountains and flooded the rivers. This led to deposition of loamy clay and sand over the surface of the river beds. During the glacial periods, on the other hand, water in the rivers being much less, it cut deep into the valleys; this process was aggravated along the lower ranges of the rivers due to the steep fall in the level of the water in the seas as well. The net result, after this alternating and repetitive processes was a series of terrace formations on the river bed—the erosion of the river beds being more than the deposition.

Prehistoric man lived mostly on the banks of the rivers so that he could easily avail of one of the necessities of life namely the water. As and when the floods came, he left the river side but in the process of leaving he also left behind, inadvertently though, his belongings and his imperishable stone implements also. Gradually as the water receded these implements got stuck up or embedded in the clay.

As this process was repeated again and again, a variety of stone tools made by prehistoric men were left behind in the terraces of some of the river beds in India as well as in some other countries.

It is they that provide us clues to his antiquity.

FOSSILIZED BONES

Curiously enough, fossilized bones of man *i.e.* the hardened ones due to being infilterated with earthy salts over long periods of time when they were buried under the earth, have not been found in plenty. This is due to the fact that man died generally in the open and was eaten up by the animals and later annihilated by the prevailing weather conditions. On the other hand, about his contemporary animals we are better informed because we have more skeletal remains of them with us. This is because of the fact that these animals got buried accidently, many a time, in lakes, marshes or in snows where they got more or less preserved. Some of them have remained life-like even after millennia.

RECONSTRUCTION OF HIS LIFE

From the physical features of the fossilized bones of the primitive men and their stone tools, the contemporary animals and the environments in which they lived, one can reconstruct the life of the prehistoric man at various stages as follows.

Man, the Homo-sapiens—as we know him now and as we are now—did not at once differentiate out of the four-legged chimps or monkeys. To reach upto the present stage of evolution, he grew out from very primitive to less primitive ancestoral men that do not live now and have long been extinct. Till lately these ancestoral men were listed chronologically somewhat as follows : Proconsul Dryopithecus, Australopithecus Dryopithecus, Pithecanthropus sinanthropus, Heidelbergman, Swancombe man, Neanderthal man, Jawa man etc. These tedious names, roughly speaking, indicate the stage of evolution of man and in some cases the names of the places from where his fossilized remains were

discovered. Leakey[3] lately discovered the existence of the earliest man-like being whom he calls Kenyapithecus Africanus—discovered from Kenya in Africa. He thinks it to belong to a period as far back as 20 million years from the present times. This statement, however, is yet unconfirmed.

Early man lived in jungle in company with other animals. He climbed up the trees at night and walked on the ground during the daytime. He collected his vegetarian and non-vegetarian food, drank water from nearby source of water and at once climbed up the trees in case bigger, more ferocious animals such as big elephants appeared on the scene. He had long arms but short legs and he certainly did not stand as erect as modern man can do. His shoulders drooped forward.

Gradually as he started living more and more on the ground, his long arms which he previously used mostly for swinging from the trees, shortened and his legs lengthened, so that now he could survey around him better with his far-reaching eyes.

LEARNS TO USE WEAPONS

If he could not run fast enough to catch an animal or if the animal was a bigger one, he noticed that he could use a stick or a handy stone to kill it. A well-pointed stick or a sharp stone was even more useful.

LEARNS TO MAKE WEAPONS

If such an object was not available, it could even be made. A branch of tree could be sharpened on one side with a sharp stone or even if a sharp stone was not available, it could be made by striking one stone against the other so that a flake was detached that was sharp enough for the purpose. Discovery that the stones and sticks could be shaped deliberately so as to serve as weapons of defence as well as of offence provided man with extra power. Though physically not as strong as some of the big jungle animals yet he could now have the better of them and could catch or kill

them and satisfy his appetite and needs.

Some of the chimps and higher apes are also known to make and use tools but they can do so only for their immediate visible needs. They cannot project their thinking into the future and thus cannot shape a stone or a stick for some future eventuality. They live mentally only in the present, and the past and the future does not exist for them in that sense. It was, however, different with man. Employment of all sorts of tools for his immediate needs as well as for the future, based upon his personal past experiences as well as those communicated through generations of men by means of workable though rudimentary spoken language, has been the characteristic of man only.

Fig. 1 Man, The Tool-Maker

Considered functionally these different tools are sort of detachable extensions of his fore-limbs. While different parts of the body under changed environments evolve out after millions of years, man can easily make new tools to serve the intended purpose in a very short time. This has provided him with a means to hold mastery over his environments and has also been the cause of his survival under extremes of climatic conditions.

COMES OUT IN THE OPEN

With this newly discovered strength man became bolder. He came out in the open more often and found that he could move undaunted over vast distances in search of food and more congenial environments. And he did move a lot—hundreds perhaps even thousands of miles and maybe from one continent to another. He

liked to and had to live near the rivers or some source of water, as next to the food water was his chief necessity. It is rather difficult for us to realise that he did not have anything to keep water in and it had not yet occurred to him that this was possible.

HUMBLE BELONGINGS

A few stone weapons or implements and perhaps a sharp strong stick, were the only permanent belongings that the prehistoric man had for ages. A more usefully shaped stone or a new technique of making one, was all that made difference to the survival of man amongst men and beasts—in the same way as more deadly atomic stockpile is for the existence of a set of people now-a-days.

Efforts to evolve a better technique of making stone implements was thus one of the pursuits of man. Alongwith it was the search for a better and more durable material of which the stone was made of. It took long long ages from one stage of development to the next. This was probably due to the rudimentary form of language, poor means of communication and too few people to communicate with.

2

Technical Skills During Different Food-Collecting Stages

Whatever knowledge we have of the technical skills of the prehistoric man in India, has become available to us through the medium of archaeological science. This medium, however, has its own inherent limitations. And here the remarks of a well-known scholar[4] are very pertinent. He wrote, "If you will look up from the page for a moment, you can make an interesting calculation. Reckon up the amount of perishable material in your immediate surroundings and then try to put yourself in the place of an archaeologist who comes to excavate your sitting room in 50,000 years time. Carpets, curtains, fabrics, leather, paper, plaster, all are perished. What is left are a few bits of glass, stone and metal. All that will survive to show that you sat snugly and in comfort in a warm room will be a few broken and unrecognisably battered remnants. Even the chair you now recognise might have disappeared. The archaeologist may exclaim, 'What quaint people they were ; they wore no clothes at all and they sat on the floor' !"

Prehistoric man certainly would have had other belongings also. He had leather in plenty and would have worn 'mink coats'—may be badly tailored compared with the current fashions. But all these perished with the passing of time except the stone tools and now it is only they that tell us of his technical skills.

DISCOVERY OF STONE TOOLS IN INDIA

Discovery of the stone tools of the prehistoric man in Europe,

as mentioned before, had its repercussions in India also. Archaeologists and other people started looking for such stone tools in the existing or extinct river beds, caves and other places. Bruce Foote[5] in 1863 found stone tools in a gravel pit at Pallavaram (near Madras). Later he and William King, discovered them in the old beds of the rivers Korttalaiyar and Narnavaram in Madras. Wynne in 1865 discovered them near Paithan (Hyderabad, Deccan) on the upper Godāvari river. Hackett in 1873 found them in a cliff at Bhutara on the Narmadā river. Ball in 1875 found them at four different sites in Orissa, and Cockburn in 1883 at Singrauli basin in south Mirzāpur. Interestingly, Cockburn, Hackett and Wynne[6] found these stone tools in association with fossils of mammalian animals which had belonged to the Pleistocene phase.

The above stray and intermittent* finds were, however, the only evidence of the prehistoric man in India till 1930.

Some of these and other stone tools recovered from the South were sent by Cammiade and Richards to Burkitt of Cambridge. He in 1930[7] and 1932[8] recognized them as belonging to different periods. He established a sort of chronological sequence among the stone tools of different types.

In the meanwhile, in northern India in Punjab at Kargil and the Salt Range south of the Potwar plateau, de Terra discovered a few stone tools himself and also saw a collection of such tools at Pindi Gheb in the valley of the river Soan, from where such tools had been collected since 1880 by Todd. Findings in this area

*Indian prehistoric archaeology in its earlier phases devoted itself more to finding antiquities and curios and neglected to correlate and record these objects to the strata from which they were recovered. In archaeological language, it cared more about horizontal digging and less about the vertical one. Moreover, prehistoric archaeology in India is still in its infancy, inspite of its having spent many decades at that stage of its development. The result is that the account of prehistoric man in India as yet, is disjointed and fragmentary and at best only the major events in relatively important areas are traceable. Much useful work has, however, been done in this direction during the past two decades and this has provided us with a picture of the Stone Age India although it must be confessed that the picture is still hazy and a lot more work is required to be done to bring that into focus.

proved so very promising that it led to a well-planned and equipped expedition in 1935 under de Terra, and Paterson.[9] This expedition, commonly called as Yale-Cambridge expedition, was intended to tell more about the past climatic conditions in Kashmir and Punjab and also to place the stone tool finds there in their proper stratigraphical layers, so as to know their sequence and their age.

This systematic work confirmed the existence of four glacial and three interglacial periods in the Kashmir valley and the south-west slopes of the Himalayas during the Pleistocene phase extending back from half to one million years, as was the case in Europe and some other parts of the world. It is likely, though unproved, that the Himalayan and the Alpine sequences approximate to one another in time. In Kashmir zone, fossilized bones of the animals such as the primitive elephant (Elephas hysudricus) were also recovered which were shown to belong to Early Pleistocene. In the Punjab zone, bones of the primitive elephant (Elephas namadicus) that there recovered were shown to belong to the second glacial period and were similar to those recovered from Narmadā and Godāvari valleys in the south. They all belonged to the mid-Pleistocene phase.

Fossils of these extinct animals, placed as they are in their different geological strata, help us to give approximate age to the stone tools that were also recovered alongwith them from these places.

DIFFERENT FOOD-COLLECTING STAGES AND THEIR TOOLS

Minute study of the individual stone tools as well as the collective surveys of the finds from different areas show us the progress in the techniques and skills known and employed by the prehistoric men at different stages. It also gives us some idea of the uses to which they put these tools and the areas and the environments in which they lived.

'All-in-One' Stone Tools from Different Sites

[To face page 11]

I. 'ALL-IN-ONE' STONE TOOLS STAGE

This is the earliest food-collecting stage of the prehistoric man. During this stage, the stone tools that he made were such that the same tool could be used for different purposes though not very effectively. The varieties of tools that come under this category are as follows.

1. FLAKES

A flake is a chip of stone struck off from a block of stone. Flakes are the earliest man-made stone tools found in the Indian sub-continent. They were found on the banks of the rivers Indus, its tributary Soan and some other rivers of Western Punjab. These flakes were present in the top-most layers of the boulder conglomerate *i.e.* the rocks along the path of the glaciers of the second glacial period. They are around 600,000 years old and belong to the mid-Pleistocene phase. To demarcate these tools from the others that belong to later periods but occur in the same region, they have been called as Pre-Soan tools, Soan being the name of the river from where they were first recovered.

These flake tools are big and quite worn out. They might have been used for a variety of purposes such as to hit the animals, to cut wood or to seek out edible roots from beneath the ground.

The technique by which these flake tools were made has been given the name of Clactonian, after the name of the site Clacton-on-sea near Thames estuary, from where tools made by this technique were first discovered. This technique can be applied by either of the following two methods :

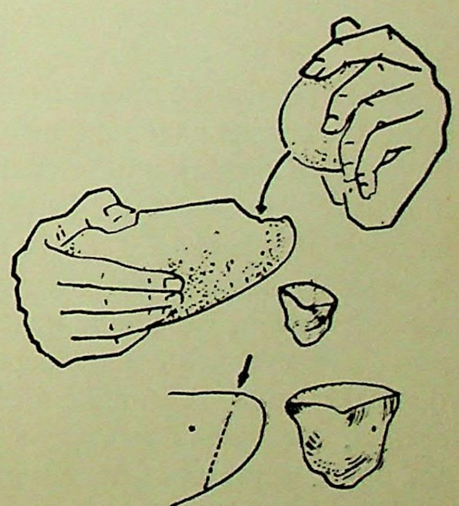

Fig. 2. Clactonian Technique : Perpendicular hit against the flat edge of a stone produces a Clactonian sliver, which can perform the function of a knife.

(*1*) *Hammerstone or Direct Percussion Method.* In this a large pebble can be used as a hammerstone to strike on a suitable stone in such a way as to detach a flake from the mass of the stone.

When a blow is struck upon a piece of stone with the convex surface of a water-worn pebble, it breaks under tension round the periphery of the area of contact and a crack spreads rapidly downwards and outwards. Ordinarily, as we know, a blow with a hammerstone on another piece of stone causes only shattering. But if the blow is of sufficient force given at a correct angle and if the stone struck is of a suitable texture, it punches out a complete cone.

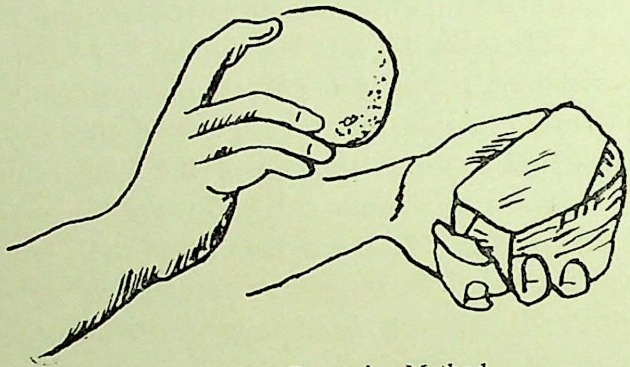

Fig. 3. Direct Percussion Method

When prehistoric man started making flakes, he had first to learn the correct angle at which to strike a blow before he could be sure of detaching a flake at the desired point and in the desired direction. He learnt this by experience and directed his blow at an angle of roughly 120° to the direction in which he desired to remove the flake. This blow was at a point near the edge of the stone from which the flake was to be detached, so that only a part of the cone of force penetrated the stone and the rest was dissipated outside. A flake thus detached had a clearly defined semi-cone or bulb of percussion, as it is sometimes called, marking the point of impact of the hammerstone.[10]

Once he had mastered the hammerstone technique of detaching flakes, he experimented and evolved out another one for detaching larger flakes. This is what we call anvil or block on block method.

(2) Anvil or Block on Block Method. In this the hammer was a fixed block of stone and the stone from which it was desired to detach a really large flake (from which a big implement could be

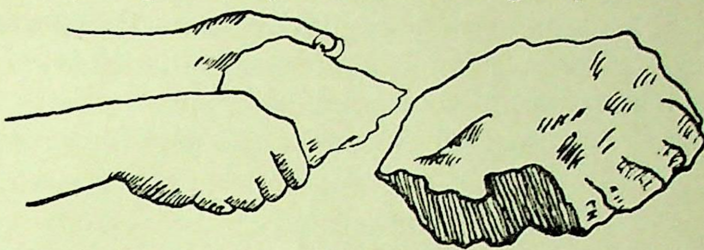

Fig. 4. Block on Block Method

made) was swung against this fixed anvil. Here again, the essential point for success was the knowledge of the correct angle at which the stone was to be struck against the anvil.

The main disadvantage of both the hammerstone and anvil methods of flaking was that the scar from which the flake had been struck had a 'deep negative bulb of percussion' at the point of impact of the original blow. Thus—since several flakes were detached in succession—the cutting edges of the tools made by these methods were irregular and jagged[11]. Obviously, something better was desirable.

2. CORES

From Soan and Indus river basins and a few other places were found other stone tools also, different from the earliest flakes that have been described before. These have been called as Early Soan tools. They differ from the Pre-Soan tools in the fact that they are made from the main mass or core of the stone and not from its flakes. They belong to the second interglacial period and are 400,000 years old. These tools are made generally from pebbles of quartzite and hence are called as pebble cores. They show a trend towards smaller and neater forms from the earlier to the later stages.

These tools were made by hammerstone or anvil method. The broken halves of the pebble stones were generally chipped from

the underside upwards so that they provided the cutting, scrapping or chopping edge, and the unchipped pebble surface on the other side served as a suitable hand-hold.

From the look and function of the tools and the nature of their edges, they have been called as choppers, chopping tools etc., the distinguishing features of each being as follows :

Chopper : A stone tool of massive size used for scrapping. It

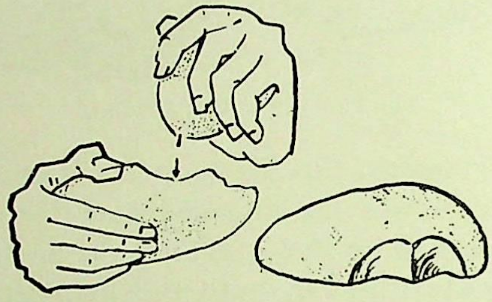

Fig. 5. Making a Chopper : Multiple Clactonian strikes transform the main mass into a Chopper

is worked on one side only and so is a unifacial tool. Choppers are characteristic tools of this, the Early Stone Age.*

Chopping Tool : A stone tool made from a split pebble core which has been flaked alternately from both surfaces in such a way that a jagged wavy cutting edge results, the rest of the sur-

*The earliest of the stone tools made by prehistoric men were initially labelled as "Palaeolithic" meaning 'of the Old Stone Age'. As more detailed studies revealed different types amongst these tools, belonging either to an earlier or a later period, further subdivisions of Palaeolithic times and tools were created as Lower, Middle and Upper. The latest *i.e.* the most recent stone tools and times were called as Neolithic and the period in between the Neolithic and the Upper Palaeolithic was called Mesolithic *i.e.* coming between the two.

This sort of classification of Stone Ages and tools, however, implies a fixed stratigraphic order which though found in Western Europe and Africa, has not yet been established clearly for all regions of the Indian subcontinent. Taking into view this fact and the confusion which the use of such a terminology in India had led to, the First International Conference on Asian Archaeology held in New Delhi in 1960, adopted and recommended the Stone Age in India to be divided into Early, Middle and Late, with a fourth period namely the Neolithic. This classification has been used in the present study also.

face retaining the original form. These tools were probably used for chopping meat or wood. They are heavy, large and bifacial. They belong to Early Stone Age but are also found in Middle Stone Age, though by that time their size had become smaller.

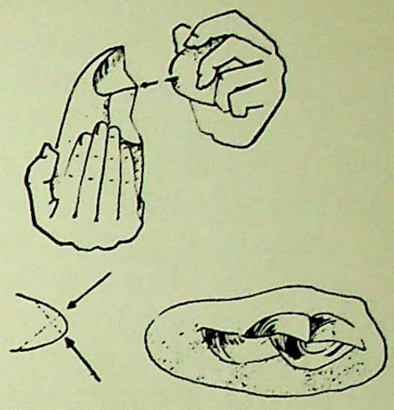

Fig. 6. Making a bifacial Chopping tool: It requires turning to the opposite side.

Contemporary with the above-mentioned pebble core tools there were core tools of another type also, which look like axe blades but were used by holding them directly in the hand and hence have been called as handaxes. These handaxes were first discovered in the south around Madras and hence tools of this type are also called as Madras industry—the term industry being applied to any set of finds which is evidently the work of a single human group. These handaxes were prepared as follows :

A flat oval piece of flint was selected. Clean glacing blows were directed up and down against both the edges of the stone, alternately to the right and to the left. The result was a flat biface with an uneven rim. This technique of making handaxes is called Acheulian—after St. Acheul near Amiens on the Somme river in France where tools made by this technique were first discovered.

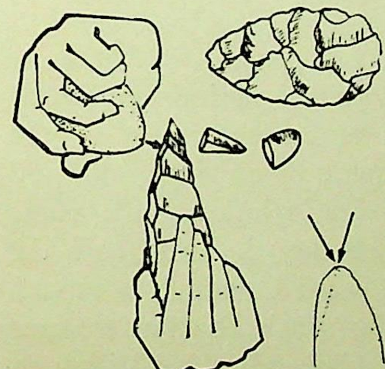

Fig. 7. Acheulian Technique.

To get an even and nearly straight cutting edge on this biface, a new technique called as cylinder-hammer technique was applied. This technique consists of knocking off lengthwise very thin flakes with very shallow bulbs of percussion by means of a round-edged hammer of comparatively soft material such as bone, hard wood or weathered stone. The essential features of

this technique are (1) that the force of the blow is directed at the actual edge of the stone struck and not at a little distance from the edge and (2) that although one particular point of hammer hits the stone first, the fact that the hammer is comparatively soft means that almost instantaneously force is applied also from other points along the rounded surface of the hammer. Thus, instead of the crack spreading from one point and giving rise to a marked bulb of percussion, it spreads from a larger area of contact through a flattened arc. This results in the removal of a flake that is very flat. A series or rather the intersections of a series of these flat flakes produce a nearly straight cutting edge.

Cleavers: Another important tool type of this period and belonging to the handaxe complex is the cleaver. This tool looks to have been used for cleaving or cutting and seems to be a distant prototype of the flat copper and bronze axes of the later periods.

A cleaver can be made out of a flake or a core. The upper side generally retains the original surface while the underside ends in a wide chisel-edge formed by intersection of two large flake scars inclined to one another at an acute angle. The two longitudinal sides which are comparatively thick are trimmed.

3. LEVALLOISIAN FLAKES

Of a still later period *viz.*, the third glacial period but found initially and mainly again near Soan and other rivers of the northern India, were the flake tools made by an ingenious and more intricate technique called Levalloisian technique—the name being derived from the word Levallois, a suburb of Paris, from where such tools were first discovered. This technique is also called as Prepared core or 'tortoise' core technique.

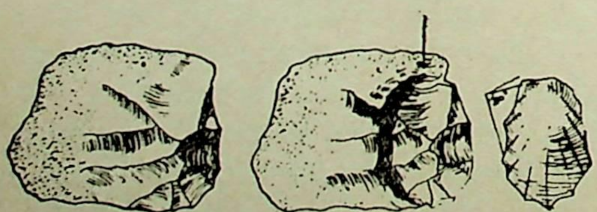

Fig. 8. Levalloisian Technique.

It differed from the earlier techniques in that the shape of the

flake to be finally struck off, was blocked out on the core or lump of stone beforehand and then removed by one single blow. This was contrary to the earlier techniques where it was customary to take either a nodule, a pebble, a lump of stone or a large flake already struck from a piece of stone and then from it were struck off a series of flakes to trim the specimen into a tool.

Comparison of the Clactonian with the Levalloisian technique of obtaining flakes, shows that in the former the blow is given anywhere on the margin of the pebble in more or less a haphazard manner so that a small or large, thin or thick flake comes off which may or may not be useful. The subsequent flaking of the core is also not pre-planned and it may result in eventual loss of the basic raw material. With the Levalloisian technique, on the other hand, though each time only one flake can be obtained and every time the core has to be prepared again so that the process is lengthy and time consuming, yet the size and quality of the flakes are assured and it is on the whole a very economical process[12].

The typical Levallois flake struck from a tortoise-core combines the plano-convex form of some handaxes with the straight cutting edge of the ordinary flake and this very well suited for use as a skinning knife.

The tortoise-core technique is interesting also from the point of view of the evolution of skill, because it implies much more forethought as compared with any of the earlier techniques.

PROGRESS IN TOOL-MAKING TECHNIQUES

From the simple flakes to the unifacial choppers and from the choppers to the bifacial chopping tools, we clearly discern technical progress. A biface required turning over of the stone to the other side and it needed judgement as to where exactly to strike and also with what precise force so as not to damage the other prepared side.

Even then a bifacial chopping tool was heavy, cumbersome all-purpose implement that was used to cut, to puncture, to scrape and to dig—but all this without any precision.

From the stage of bifacial tools to the Acheulian handaxes was a further step forward. This involved (1) Choosing an appropriate piece of stone in which the man's mind had already foreseen the form of the implement to be fashioned. (2) It required trimming by using the minimum number of strokes. (3) A new technique of working on it lengthwise, was used, to give the implement its pre-final shape. (4) Use was made of a wooden hammering device which in itself is a new instrument for precise lengthwise trimming of the edges. This new edge thus formed was far more superior technically as compared with that found in the earlier tools.

These improved techniques led to economy in the use of the raw material. From one kgm. of the requisite stone, the earlier prehistoric man knowing only the flake or biface technique, could fashion only a rude jagged cutting edge, 2 to 4 inches long. But from the same quantity of stone, the later man knowing the techniques of making Acheulian handaxes could make two tools each with a good cutting edge more than 6 to 8 inches long. Levalloisian technique further assured the quality of the flake tools and also proved more economical in the use of raw material.

This aspect had its other more favourable repercussions. The ability of the later man to make more handaxes with better and longer cutting edges from a given material, helped him in moving about much more and for longer periods in search of food or other congenial environments. He did not have the need to stick around the areas where the requisite stones were available. Vice-versa this lure of moving to far off places created the necessity to produce more handy, easily portable, better and longer-lasting stone tools.

It must, however, be remembered that when we say that the particular flakes or cores belong to a particular period, it only indicates that a particular type was the predominant one amongst the finds. The other type of tools also existed and have been found—and that is what is expected also—as it is easily understandable that while making core tools the flakes unavoidably are produced and a nicely shaped flake can easily be used, though what was intended was a core tool.

AREA DISTRIBUTION

'All-in-one' tools of different types have been found in the northern as well as southern India and over many other parts of the Indian subcontinent. Important sites from where these tools have been discovered so far are as follows : valleys of the river Indus and its tributaries in West Punjab, valleys of Sirsā[13], Beās and Bangangā[14] in East Punjab, Singrauli basin[15] and Yamunā valley[16] in Uttar Prādesh, Roro valley[17] in Bihar, Kāngsabati valley[18] in West Bengal, Burhabālang valley[19] in Orissa, Bhavanasi[20] and other rivers, Krishna valley[21], Karempudi and Nāgārjuna Konda in Andhra, Korttalaiyer[22] valley in Madras, Malaprabha and Ghātaprabhā basins[23] in Mysore, Godāvari basin[24] in Mahārāshtra, Sabarmati[25] and Mahi valleys in Gujarāt, Narmadā valley[26] in Madhya Prādesh, Chambal basin in Mālwa[27], Banas[28], Gambhiri and Luni valleys[29] in Rājputanā. Except for Sind, Saurāshtra, Kerala, Tinnevelly in the extreme south, Assam, Nepal and Kashmir, these tools* have been recovered from all over India.

Initial studies of the tools recovered from the south and central India and of those from the north, had shown different tools types and traditions. This had led various authors to believe that the man in the north was different from that in the south or central India. More recently, Soan type of tools have increasingly been found as far south at Kurnool in Andhra State and in appreciable number in Mahārāshtra, north Gujarāt, southern Rājputanā, east Madhya Pradesh, Uttar Pradesh and in Orissa. In the Punjab itself at a site called Chauntra, co-occurrence of both the Madras and the Soan type of stone tools, in the third glacial period, has been found. The two types of tools, however, are not found together at the same site but at different localities in the same river valleys. This perhaps indicates that the man at this period was the same all over the Indian subcontinent and he produced different stone tools depending upon the local environmental conditions.

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* These tools are called by archaeologists as Early Stone Age tools.

LIFE IN THIS PERIOD

Finding of these stone tools in the above-mentioned vast areas over large parts of the Indian subcontinent indicates that even in these early times, men lived in small and large communities. They participated in collective endeavours such as of catching and killing the animals for food etc. The same type of the techniques of making the stone implements over large adjacent and far-flung areas also indicates a fair amount of communicability between them. It also indicates that man of that time had started experimenting with different techniques and had come to plan, design and execute a particular standard type of tool for his needs. From the finding of a fairly large number of tools, one can infer that even at the time of second glacial period, around 600,000 years from now, tool-making was not just an occasional but a regular pursuit of mankind and that it served man's particular needs at that time.

Use of not easily available but durable material indicates that the man searched for such stones, may be unearthed them and brought them to the place of his work and residence. He understood the use of different stones and their physical properties, which knowledge gradually formed the basis of the physical sciences.

II. SPECIALIZED STONE TOOLS STAGE

The next stage in the development of the mind and skills of man in India was the appreciation and understanding of the fact that instead of using an all-purpose, 'all-in-one' tool which at best performed rather crude functions, he could make tool which performed, generally speaking, only one function for which it was made but that function it performed efficiently and effectively. Understanding of this fact was certainly a great advance in the thinking of man and it gave a spur to technology and led to multiplication of different types of tools. These specialized tools required special harder material also and we find that fine-grained material like chert, jasper, chalcedony and agate is used in place of trap, quartz or quartzite of the earlier period.

Specialized Stone Tools from Different Sites

[To face page 20]

Thus the handaxe complex gave place to tools such as scrapers, borer-cum-scrapers, borers or awls, points, burins etc., the characteristic features of which are as follows :

Scrapers : These were, perhaps, meant for scraping things like tree barks, wood, animal hides etc. According to the shape of the particular scraper and the position and nature of the edge for scraping, it has been further named as side-scraper, end-scraper, round-scraper, hollow, concave or convex scraper.

Borer-cum-Scrapers : These tools are also characteristic of this period. In them the projecting borer and as well as the adjoining cavities are retouched. This serves as guard for the object to be bored and also for the tool itself and provides a suitable handhold.

Points : These tools have been found in different sizes and shapes such as large or small, thick, medium or thin, triangular or semi-triangular—some of them with a beautiful finish. The smaller ones might have been used as arrow-heads while the larger and thinner ones with a mid-ridge as javelin or spear heads.

Borers or Awls : These tools have either a small or a large thick projecting point which is carefully retouched. The bodies of these tools possess different shapes.

Burins : These are small chisel-like tools made on blade-like flakes, having a sharp but thick-set cutting edge, formed by the intersection of the bevelled or sloping surfaces. Though rare, a few of such tools have been found in India.

All these tools are made on flakes or flat-based nodular stones. Besides the Clactonian, Acheulian and Levalloisian techniques employed in making flakes for these tools, there is evidence even of the application of pressure-flaking technique at the retouched margins of some of the points, borers and scrapers.

Retouching in these implements could have been done by the Acheulian technique, but that had the disadvantage of breaking the tool by an inadvertent false blow. To avoid this loss, it was discovered that the same or even better result could be had by an easy and more accurate technique namely that of pressure-flaking. The pressure-fabricator was indeed one of his great inventions. This tool was not specialised in form. All that was needed was any

rough flake in which there was somewhere a thick, more or less rectangular edge. By holding the fabricator in one hand and placing its end against the edge of the flake to be retouched and exerting pressure, little flakes could be pushed off very rapidly and with practically no risk of snapping the blade[29a].

These specialized tools were not only helpful in performing accurate specialized jobs but they also yielded larger cutting edge per kgm. of the raw stone. From one kgm. of stone, on an average, four implements could now be formed having a total of about a yard of the cutting edge. The effect of this was that a few kgms. of stone, which a man could easily carry about him lasted a much longer time. This provided him even greater mobility over a larger area.

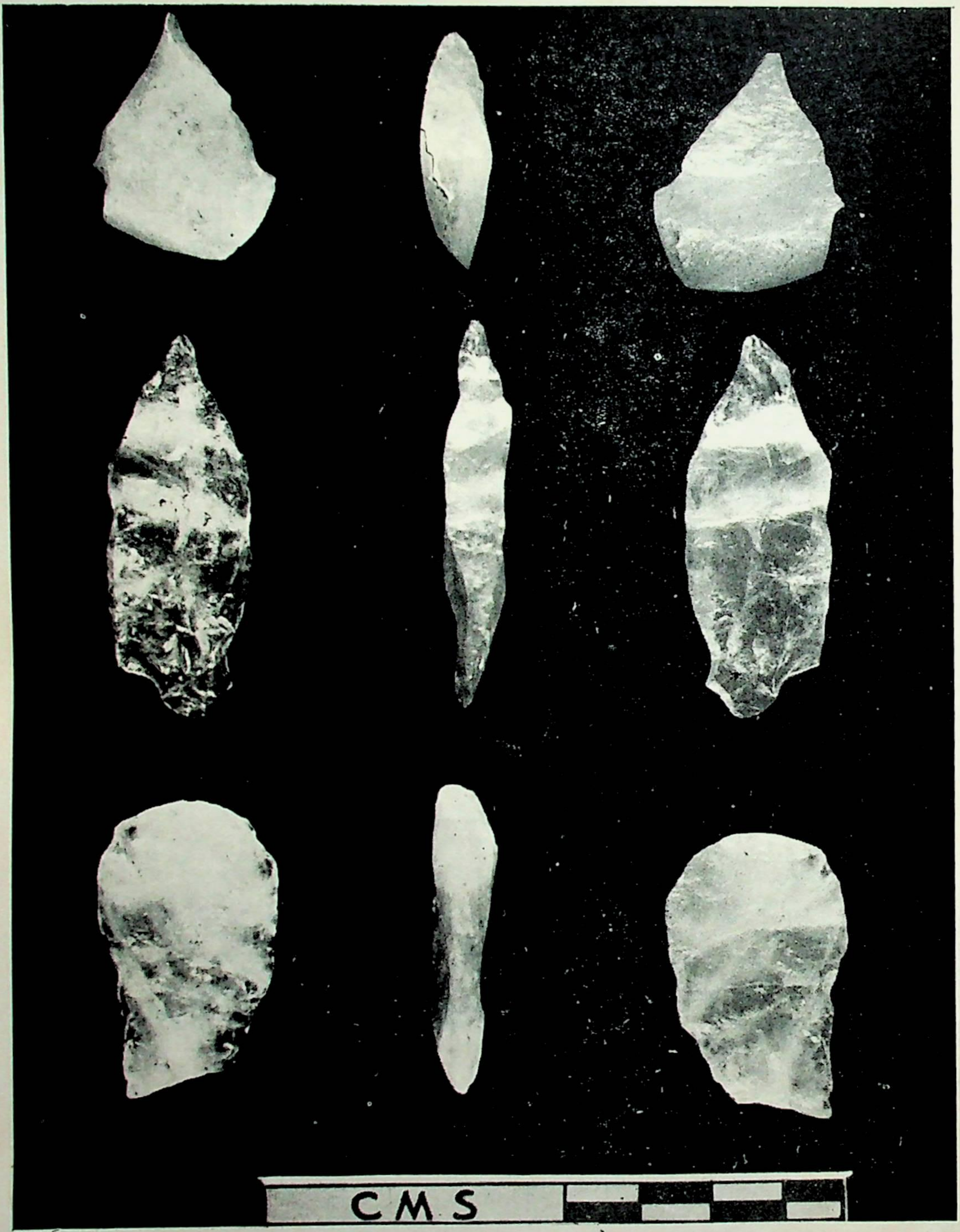
AREA DISTRIBUTION

These tools in India were found for the first time at Nevasa on the Pravāra in district Ahmednagar in 1954-55[30]. Later on, they were found along Godāvari at the sites Bel-Pandhari, Surgaon and Kalāgaon, around Maheshwar on the Narmadā in district Nimad and many other sites in Madhya Pradesh in Mahārāshtra (including Konken), north Mysore, Andhra (particularly northern districts), Bundelkhand (which includes south-western Uttar Pradesh), Orissa, Western Rājputanā, Saurāshtra and perhaps in Madras and in Sind at Sukkur. Area distribution of these tools can thus said to be more or less co-extensive with that of the 'all-in-one' tools.

Such tools were hitherto found only on the surface and because they were comparatively small, they were considered to be part of the microlithic tools which came later on. Recent study of the stratified deposits has, however, helped to place them in their correct chronological order. They occur in gravel overlying the earlier deposits and underlying the later deposits containing microlithic tools.

LIFE IN THIS PERIOD

Shape of these stone tools, different as it is from the previous ones, indicates that the prehistoric man of this period hunted and



Composite Stone Tools (Microliths)

[To face page 23]

collected his food in ways different from the ones adopted by the earlier man. He hunted with a spear or javelin and perhaps with a bow also, as the tanged points indicate. The hollow scraper might have been used to scrape and smoothen the shafts of these weapons while the borers or awls were for piercing the skins of animals etc. Men seem to have lived on river banks and near rocks where the raw-material for the tools was easily available. The country must have been fairly wooded, though perhaps less thickly than during the previous Early Stone Age.

This period has been given the name of Middle Stone Age by the archaeologists.

III. COMPOSITE STONE TOOLS STAGE

Roughly, from 10,000 to 7,000 years B.C., (following the four glacial periods), a further stage in the technological development of man occurred. It is as interesting as it is ingenious. Instead of making a whole tool from a block of stone which for ever served only one purpose, man made smaller specialized parts of the tools and fixed these parts together for whatever function he desired.

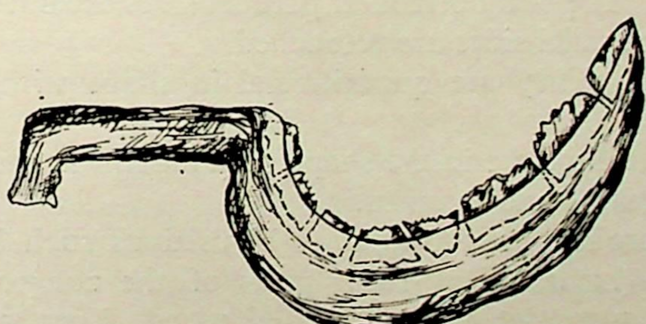


Fig. 9. Composite Tool.

Dismantling of the worn out part or a component of such a tool and adding a new one in its place saved the labour and material of making an entirely new tool. This most ingenious idea in later ages, when the metals became available, was used in making more complex contrivances and machines to serve a variety of needs.

The microliths, the small parts of the composite tools, as they have been called, were made in different shapes, non-geometrical as well as geometrical, as follows.

Cores: These cores measure ½ to 2½ inches in length. Usually they are of three types: (1) Pointed or conical, (2) Flat-based and (3) Chisel or oblique ended.

Blades: A blade is a long narrow flake with nearly parallel sides, struck off a core. It is thin and flat as compared with its length. It may have plain or faceted striking platform. These blades are often retouched and it is this retouching which distinguishes them from any other ordinary chip of stone. Such retouched blades are either (1) single straight-sided, (2) double straight-sided, (3) straight but pointed at one end, or (4) straight with one end curved.

Crescents or Lunates: These microliths have the shape of a crescent moon, the arc being thickened and blunted for hafting and the straight side being retouched.

Triangle: Whether regular or irregular in shape, the largest side is blunted and the opposite angle and sides are retouched.

Trapeze: The two horizontal parallel sides are untouched but the two non-parallel sides are retouched.

Trapezoid: They are quadrilateral in shape with two sides parallel.

Other microliths are in the shape of (1) arrow heads, points or awls, micro-burins and scrapers.

These microliths are too small to be used as such by holding them in the hand. They form parts of the compound tools. These chips were set in handles of wood, horn or bone by means of tree-gum or some other adhesive, as is indicated by the discoloration of some of their facets away from the cutting edge. Appropriately fixed, these microliths served as javelins, barbed harpoons, arrows, knives, sickles etc. Some of the sharp-pointed flakes were, perhaps, used as needles or awls for stitching the hides.

AREA DISTRIBUTION

Important sites from where these microliths have so far been found are Birbhānpur[31] on the bank of the Damodār river in district Burdwan of West Bengal, Singrauli basin in eastern Uttar Pradesh, Mayurbhanj, Keonjhar and Sundergārh in Orissa, in Andhra, Tinnevelly[32] in the extreme south, Chitaldurg and Bellary in Mysore[33], north Karnātak, different sites in Mahārāshtra, and Gujarāt particularly at Langhnaj[34], in Madhya Pradesh and Rājputanā. In short, the microliths have been found all over India except in Assam, the Punjab plains and Kerala. At some of these sites, these microliths, were found in association with larger stone implements such as the handaxes and scrapers belonging to the older periods. At others, the deposits in which these tools were found do not look to be too old and in fact belong to early historic times.

LIFE IN THIS PERIOD

Some idea of the life and times of the people who manufactured these microliths can be had from the excavations and finds from northern and central Gujarāt. These people lived in regions interspersed with elevated areas and lakes. Hunting and fishing formed their chief source of food. These activities they carried out with their tiny tools. They still belonged to the food-gathering stage though they were more developed in their techniques of making tools as compared with the people of the earlier times. This period has been called Late Stone Age by the archaeologists.

This type of life did not continue on much longer due to various factors, one of which was the climatic changes that changed the environments of man, making his living by food-gathering, hunting and fishing alone, difficult. With his instinct for survival, he again thought, observed, planned, experimented, designed and

came out with the fresh idea of producing food instead of collecting it and that marked the beginning of agriculture and the next stage in the technical progress of man.*

*Between the food-gathering stage of the last period with its microlithic tools and the food-producing stage of the Neolithic period which comes next, there was an intervening period which has been given the name of Proto-Neolithic. This was the time when microliths were used by people who were not solely dependent for their living on food-gathering and hunting, but lived in relatively settled communities and practised some form of agriculture.

Evidence for the existence of such communities in India has been unearthed in certain places. At Kile Gul Muhammad near Quetta in Baluchistān on the north-west of the Indian subcontinent, people of this period lived in mud-brick houses. Abundance of animal bones in and near these houses has been shown to indicate that these people domesticated cattle. Carbon-14 dating for a piece of charcoal from this settlement places it between 3690±515 B.C. At an other similar site namely Langhnaj, a pestle and a quern was also found in what looks like a pre-pottery settlement. These two sites were certainly not the exceptions and it appears that this type of Proto-Neolithic culture was fairly extensive all over, though all these settlements did not exist at one and the same time. In certain places they appeared earlier while in others later.

Besides using other stone tools, people in this period used knives and chisels made out of stone blades. They vary in length from 2-3 inches. These bladed tools have more or less parallel edges and were made by a special technique called as blade-flake technique, in which the stone was first prepared and then long parallel-sided flakes were struck off from it one after the other. These tools indicate the superior techniques employed in their making. While from a kgm. of raw stone the earliest man by making flakes could get only two inches long cutting edge and later on, handaxe provided 8 to 12 inches, with the development of the technique of blade-making, man of this period could get as long as 10 feet of the cutting edge from the same material.

3

Technical Skills During Early Food-Production Stage

Transition from mere food-collection to food production was a revolutionary change. It ushered in a new era and changed the structure of the human society for all times to come. New techniques and skills developed consistent with the changed conditions.

Alongwith agriculture, other secondary characteristics of this period were domestication of animals, use of pottery and of the 'polished' stone tools. These features of this (also called Neolithic period) indicate that man was no longer a hunter moving from place to place.

AGRICULTURE

The fact that different plants grow from their seeds and bear cereals, grains or fruits, must have been known to man in much earlier times also. Nuts, pips of fruits, brought in by food-gathers and edible roots, must have often germinated near camp sites, and seen to sprout forth from earth. The great moment, however, was when it occurred to man to make use of these observations and to produce his own food instead of just to collect it, as he had done hitherto.

Once conceived, the idea of cultivation, must have been applied to different kinds of edibles. Rapidly growing plants such as vegetables, pulses, cereals were perhaps the earliest to be tried. Later on, however, other useful plants, as for example fruits, timber, different fibres, condiments, glues, flex, hemp, cotton and

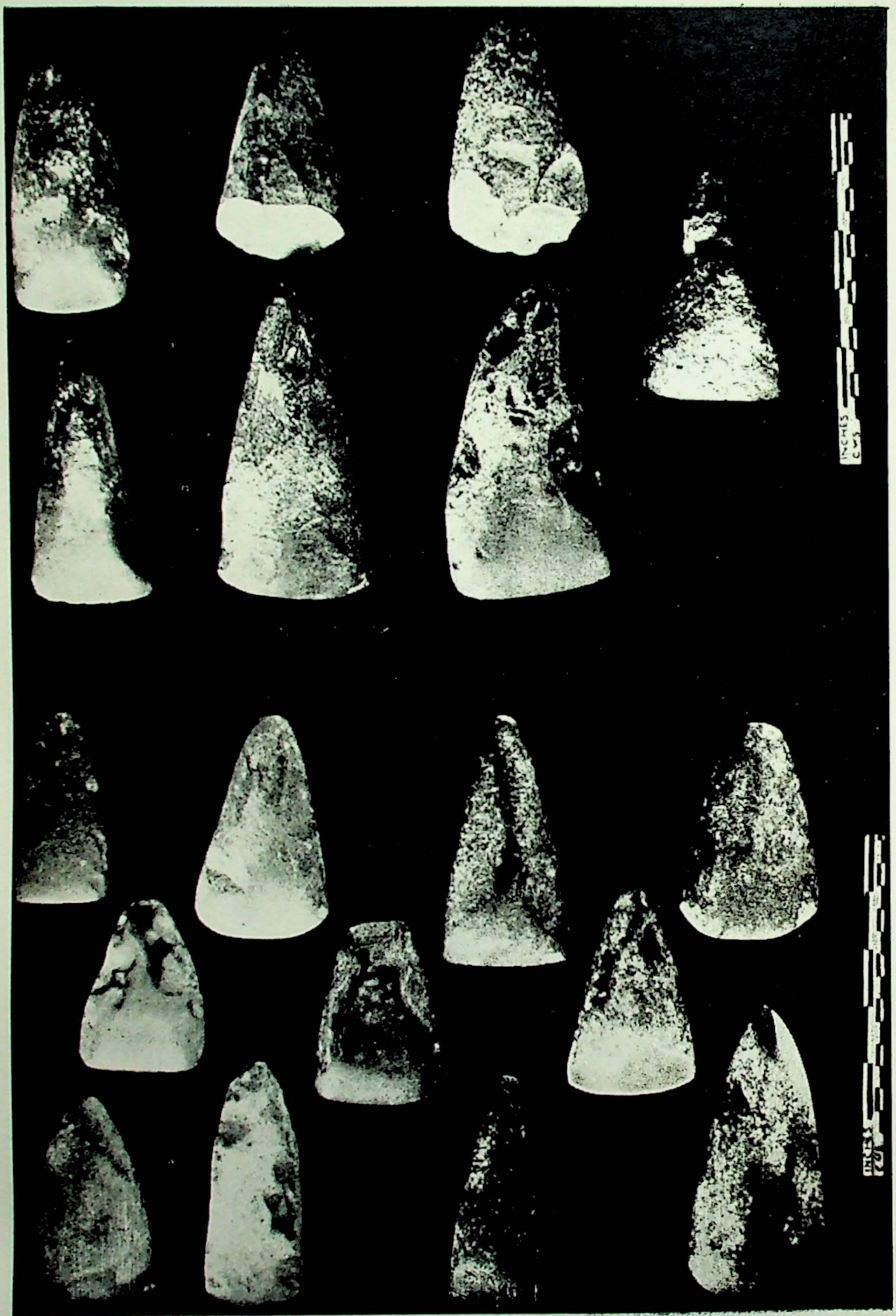
dye-stuffs like madder, saffron and indigo must have been cultivated as well.

Besides satisfying the food needs, agriculture made it possible to produce some of the above non-nutritional but technologically useful products. This resulted in the development of new techniques for their utilization. Different types of plant fibres were used for basketry, mat- and rope-making and perhaps for weaving of textiles as well. Availability of fodder in plenty, as a by-product of growing cereals and grains, made it possible to domesticate cattle. Need to transport food-grains to the market places helped in the development of wheeled transport. Furthermore, agriculture necessitated the development of new tools, such as hoes, ploughs, harrows and also the invention of food-storing devices.

Agriculture necessitated end of the nomadic life (at least when the crop was growing). Also by ensuring a regular food-supply it made possible permanent settling of the agriculturist or farmer on his own piece of land. This gradually led to settlement of peasant village communities and the start of a new mode of living.

DOMESTICATION OF ANIMALS

There is no evidence to show that man acquired the habit of keeping animals before he reached the stage of living in social units of some size. The first animal to be domesticated seems to have been the dog. The next was perhaps sheep, depending, of course, upon the climatic conditions. Cattle became domesticated only after the advent of agriculture, when plenty of fodder became available as a by-product. The beasts of burden, the ass and the donkey, were also domesticated in Neolithic times when there was need for someone to carry heavy loads of farm-products. Domestication of each of these animals occurred to fulfil particular needs of man *viz.*, the dog to keep watch or to hunt alongwith, the sheep for wool, the cattle for milk and the donkey to lift the load or for a ride.



Ground and Polished Stone Tools (Neoliths)

[To face page 29

POTTERY

After man had grasped the idea that water, semi-solid food and other essential articles could be carried along with or stored in suitable containers, he felt the need for more and more sophisticated utensils for this purpose and he applied his mind towards this need. A hollow stone, a skull bone or gourd served this purpose admirably, but an adequately sun-dried and appropriately shaped container made out of a suitable clay was even better, and if such an object had further been heated in fire, it could later be put onto the fire and the edibles cooked in it ! This container—the pottery—had all the requisites that were needed in a container.

People took such clay as they found on the surface of the ground or by some river-bed, and spreading it out on a stone slab, picking out the rocky fragments, then beating it with the hands, stones, wood, or even by treading it with their feet, proceeded to fashion it into such shapes as need or fancy dictated. Fired in the open such pottery comes to possess buff, drab brown or red colour and the imperfectly fired articles come to have smoked, gray or black colour. Different clays produced different colours in the pots, some of which were liked and appreciated by the people more than the others. Thus arose the colour decoration on the pottery.

For ages, tools and methods remained the simplest—the fingers for shaping or building up the vessels, a piece of mat or basket-work for giving initial support to a large vase etc., until some original genius of the tribe found that by starting to build up his pot on the flattened side of such a stone which could revolve also, he could bring every part of the pot in succession under his hand. Thus was invented the potter's wheel.

POLISHED STONE TOOLS

During the earlier Stone Ages, the stone tools showed gradual improvement in the techniques of their preparation but their surfaces remained rather coarse and uneven. It was only in the

Neolithic Age that these rough surfaces were ground to make the tool either partially or wholly smooth-surfaced. This was to facilitate working with them and also to make them less prone to damage during use and to enhance their durability.

For this purpose, first a stone was fashioned into the desired shape of the tool. In the second stage marked irregularities or ridges were removed with the help of a pointed tool by pecking, battering or hammering. This tool was now ready for grinding in the third stage. It was then moved to and fro in a smooth groove of a larger stone on which had been smeared a mixture of sand or a similar substance and water, to serve as an abrasive. Bit by bit the surface of the tool was thus ground smooth. Some of the very smooth tools on the surface of which even light is reflected, seem to have gone through a further stage, namely that of polishing.

Different types of such tools that have been found are (1) celts or axes, (2) chisels, (3) adzes, (4) saddle querns and mullers, (5) ring stones etc. The axes, adzes and the ring stones seem to have been hafted in different ways. These tools are made from fine-grained stones such as dark green trap, diorite, basalt, slate, gneiss, sandstone and quartzite.

All these tools indicate not only the new techniques of their preparation but also the new mode of living of the people who made them. With the help of these tools they took the first steps in agriculture, grinding of cereals and grains, wood-cutting and carpentry, mining and quarrying etc. Their tools are not only the direct fore-runners or proto-types of metallic tools but they also paved the way for the next stage of man's technical advance, namely of metallurgy.

AREA DISTRIBUTION

If we apply strictly the above-mentioned criteria of the Neolithic Age and culture, we see that only a few sites of pure Neolithic Age have so far been identified in India. While in western India it existed along with the preliminary use of metallic tools

and implements, in other parts it co-existed with the use of microlithic stone tools of the previous age. Yet Neolithic culture has been found spread all over India. It is, however, interesting to remember that while during the earlier period, the entire Indian sub-continent showed a fair amount of uniformity in its development, this uniformity was disturbed in the Neolithic period. More advanced centres of human culture and endeavour appeared at different places from where the influence spread peripherally. That is why there is no one time or period indicative of the appearance of Neolithic culture all over India. In some places it seems to have appeared before the start of historic period and in others it co-existed with the historic times.

4

Advent of Metals

Long long ago, man observed that there were certain 'strange stones' which possessed properties quite different from those of the ordinary ones. When thrown in fire, some of them became so soft that they could be given a requisite shape on hammering, and then they maintained that shape after being cooled. Other such 'stones' just melted when thrown in fire. Some of these 'stones' proved better than the ordinary ones for making weapons and tools and hence they were valued and sought after. Techniques already known for making stone tools were applied to them alongwith some other new ones such as hammering, cutting, grinding etc. These 'stones' were, in fact, nuggets of the metals like copper, gold, silver or meteoric iron. This stage of the discovery of metal has been called as the Native Metal Stage.

Later it was discovered that a particular kind of metal could be obtained from a particular kind of ore-stone. Some of these ores or metals could also be heated together to get a new kind of material—an alloy, having more worthwhile properties for making tools, implements etc. This stage has been called as the Ore Stage. This happened in many parts of the world in the fourth millennium B.C.

Metal-Stone (Chalcolithic) Stage

It must, however, be remembered that the introduction of metals did not bring about an immediate end of the stone implements. Stone implements were deep-rooted in tradition and they had behind them a variety of techniques developed over millennia and hence for certain purposes they could not be replaced.

Secondly, metals were not then available in that abundance as the stones were. Hence stone tools were continued to be used side by side with the metallic ones, and for some particular purposes, are still being used.

CALCOLITHIC CULTURES

During the past decade or so, archaeological excavations at various sites have brought to light existence of different chalcolithic —using both stone and metallic tools and implements—cultures in the Gangetic valley and Peninsular India. These cultures which have been labelled either according to the site of discovery or the characteristic pottery, are the Painted Grey Ware or Gangetic culture[35], Ahar culture[36], Mālwa culture[37], Gilund culture[38], Sothi culture[39], Nāvdatoli culture[40], chalcolithic cultures of Deccan[41], Nevasa culture[42] etc. They existed either prior to or contemporary with the Harappān civilization, which indicates that contrary to the previous impression, the rest of India south of the Punjab and Sind was scattered over with large number of peasant village communities and cultures.

Whether these cultures originated independently or derived stimulus for their growth from people coming from Iran or central and western Asia, cannot be said with any certainty at present. The answer to this still belongs to the future researches.

While we do not yet know enough about the chalcolithic communities of the Gangetic and Peninsular India, we do know something about similar communities that lived in the Western Indian subcontinent. This knowledge though still fragmentary, has become available to us through the pioneering efforts of the prominent archaeologists such as Aurel Stein[43-47], Majumdar[48], Mackay,[49] Wheeler[50], Piggott[51-54], Fairservis[55-57], etc.

During the fourth and third millennia B.C., if not before, in the borderland region of the Iranian plateau and the Indian subcontinent, in Baluchistān, Makran and Sind, there flourished different tribal and village communities, all of which had more or less similar standard of living and technical development. By 3000

B.C. they all had good quality wheel-turned and well-baked potteries, differing, however, in their designs and motifs from community to community. They made and used stone implements, predominant among which was a simple chert blade. They were also familiar with copper and bronze, though they used it sparingly. These communities had contacts among themselves as well as with the cultures to their west. They were agricultural-cum-pastoral people and it is likely that for irrigation of their fields they erected masonry dams to store water and to use it according to their requirements. Of these, the following are well known.

Quetta Culture : It is called Quettā Culture as it was found in the immediate neighbourhood of Quettā. People here lived in houses made of mud or mud-bricks. It is the earliest such culture in this region.

Amri Nal Culture : Next in time to Quettā culture seems to be the Amri-Nal culture whose characteristic pottery was excavated from the two sites, namely Amri in Sind situated on the west bank of the Indus, 80 miles south of Mohenjo-daro and Nal at the head of the Nal valley in Baluchistān. These people also lived in houses made of mud-bricks. They seem to have been familiar with bronze. In its later phases, Amri shows evidence of its contemporaneity with Harappā.

Kulli Culture : Kulli culture, discovered at the site of the same name in south Baluchistān, is similar to Amri Nal, but it had well-defined contacts with Harappān culture in the form of actual imports of Harappān products. It looks that Kulli and Harappan cultures flourished side by side. There is, however, no evidence at all available to show the use of burnt-bricks at Kulli.

Similar settlements existed in north Baluchistān also, characterized by Red Pottery Ware but with distinctive points of difference in that they were more akin to the Red-Ware cultures of Persia rather than to the Buff Wares characteristic of south Baluchistān sites.

Who were the people that lived in these chalcolithic communities at the north-western borders of the Indian subcontinent ? Were they local people or they arrived there from somewhere else ? Did they come from the side of India proper or from the

west of the Indian subcontinent where such traditions did exist? Answers to these perplexing yet important problems still lie in the future. In the meanwhile we shall proceed ahead and have a look at events that followed.

While in the rest of the Indian subcontinent including the Gangetic valley and the Peninsular India, chalcolithic agricultural-cum-pastoral village conditions prevailed for many more centuries to come, a great city civilization appeared on the north-west, whose study reveals the marvellous technical skills of its inhabitants.

REFERENCES

1. *Cited by* Oakley, K.P — 1963 — Man, The Tool-maker. 5th Ed. Printed by the order of the trustees of the British Museum, London.
2. Clark, J.G.D. — 1957 — Archaeology and Society. London.
3. Leakey, L.S. B. — 1960 — The origin of the Genus Homo. in Sol Tax (Ed.) Evolution of Man. Vol. 2, Chicago.
4. *Cited by* Marjorie & Quennel, C.H.B. — 1952 — Everyday Life in Old Stone Age. 4th Ed. B.T. Batsford Ltd., London.
5. Foote, R.B. — 1866 — On the occurrence of stone implements in various Madras and North Arcot Districts. Madras. J. of Litt. & Sc. III Series, Pl. 2.
6. Krishnaswami, V.D. — 1947 — Stone Age in India. Ancient India No. 3, pp. 11-57.
7. Cammiade, L.A. & Burkitt, M.C. — 1930 — Fresh light on the Stone Ages in south-east India. Antiquity IV, pp. 327.
8. Rickards, F.J. Cammiade, L.A. & Burkitt, M.C. — 1932 — Climatic changes in south-east India during Early Paleolithic Times. Geological Magazine LXIX, No. V.
9. de Terra, H. & Paterson, T. — 1939 — Studies on the Ice Age in India & Associated Human Cultures. Carnegie Instt. of Washington. Publication No. 499.

10.	Leakey, L.S.B.	1954	*in* History of Technology. Vol. I. p. 129. Ed. by Singer C. et al, Oxford.
11.	Leakey, L.S.B.	1954	*Op. cit.* p. 131.
12.	Leakey, L.S.B.	1954	*Op. cit.* p. 132.
13.	Sen, D.	1955	Nalagarh Palaeolithic culture. Man in India, Vol. 35, pp. 177-84.
14.	Lal, B.B	1955	Palaeoliths from the Beas and Banganga Valleys. Ancient India No. 12, pp. 58 92.
15.	Krishnaswami, V.D. & Soundararajan, K.V.	1951	The lithic tool-industries of the Singrauli Basin, District Mirzapur. Ancient India No. 7, pp. 40-65.
16.	cited by	1955-56	Ind. Arch. Rev. p. 4.
17.	Sens, S. *et. al.*	1960	On the occurrence of paleoliths in Singhbhum. Man in India, Vol. 40, p. 168.
18.	cited by	1959-60	Ind. Arch. Rev., p. 48.
19.	Bose, N.K.	1958	Geological & Cultural evidences of the Stone Age in Mayurbhanj. Man in India No. 14, pp. 49-113.
20.	*cited by*	1959-60	Ind. Arch. Rev., p. 11.
21.	Soundararajan, K.V.	1958	Studies in the Stone Age of Nagarjuna-konda & Its Neighbourhood. Ancient India Vol. 38, pp. 49-55.
22.	Krishnaswami, V.D.	1938	Changes of prehistoric man near Madras. J. of Madras Geographical Ass , Vol. XIII, pp. 580-590. And Pre-historic man around Madras. Ind. Acad. of Scs. No. 3, pp. 32-35.
23.	Joshi, R.V.	1955	Pleistocene studies in the Malaprabha basin. Poona & Dharwar.
24.	Sankalia, H.D. *et al*	1960	From History to Prehistory at Nevasa. Poona, p. 528.
25.	Zeuner, F.E.	1950	Stone Age & Pleistocene Chronology in Gujarat.
26.	de Terra, H. and Paterson, T.T.	1935	*Op. cit.*
27.	Khatri, A.P.	1958	Stone Age Cultures of Malwa. Ph. D. Thesis in Arch. Univ. of Poona and Deccan College Lib.

28.	Misra, V.N.	1961	The Stone Age Cultures of Rajputanā. Ph. D. Thesis in Arch. Poona & Deccan College Lib.
29.	Misra, V.N.	1961	*Op. cit.*
29.a.	Leakey, L.S.B.	1954	*in* History of Technology, Vol. 1, p. 137 Ed. by Singer C. et al. Oxford.
30.	Sankalia, H.D.		Ancient India. Series II Tools No. 12, pp. 35-52.
31.	Lal, B.B.	1958	Birbhanpur etc. Ancient India No. 14, pp. 4-48.
32.	Zeuner, F.E. & Allchin, B.	1956	Microlithic sites of Tinnevelly. Ancient India No. 12, pp. 4-20.
33.	Seshadri, M.	1956	The Stone using cultures of Prehistoric Mysore. London.
34.	Sankalia, H.D.	1956	Microlithic Industry of Langhnaj. J. Gujarat Res. Soc. Vol. XVII, pp. 275-84.
35.	Wheeler, M.	1959	Early India & Pakistan. Thames & Hudson, London, p. 129.
36.	Agarwala, R.C.	1954-55	Ind. Arch. Rev. pp. 14-15.
37.	Sankalia, H.D. *et al.*	1958	Excavations at Maheshwar and Navdatoli, Poona and Baroda.
38.	*cited by*	1959-60	Ind. Arch. Rev., pp. 41-46.
39.	Wheeler, M.	1959	*Op. cit.* pp. 124.
40.	Wheeler, M.	1959	*Ibid.*, p. 142.
41.	*cited by*	1954-55	Ind. Arch. Rev., p. 13.
		1956-57	Ind. Arch. Rev., p. 17.
42.	Sankalia, H.D. *et al.*	1960	From History to Prehistory at Nevasa. Poona.
43.	Stein, A.	1904-5	Report on Archaeological Survey Work, N.W. Frontier & Baluchistan. Baluchistan Distt. Gazetteer, Vol. 2, pp. 44-49, Allahabad.
44.	Stein, A.	1929	An Archaeological tour in Waziristan & Northern Baluchistan. Memoir Arch. Survey of India, No. 37.
45.	Stein, A.	1934	The Indo-Iranian Borderlands. Their pre-history in the light of geography and recent exploration. Man. Vol. 36, No. 16.
46.	Stein, A.	1935	The Indo-Iranian Borderlands. Their pre-history in the light of geography

and recent exploration. J. Roy. Anthropological Instt., Vol. LXIV, pp. 179-202.

47. Stein, A. 1937 Archaeological Reconnaisance in N.W. India and S.E. Iran. London.

48. Majumdar, N.G. 1934 Explorations in Sind. Memoirs Arch. Survey of India No. 8, pp. 172.

49. Mackay, E. 1930 Further links between ancient Sind, Sumer and elsewhere. Antiquity. Vol. V., No. 20, pp. 459-73.

50. Wheeler, R.E.M. 1946 India's Earliest Civilization : recent excavations in the Indus Basin. Illustrated Lon. News, pp. 158-59.

51. Piggott, S. 1946 The Chronology of Prehistoric N.W. India, Ancient India, No. 1, pp. 8-26.

52. Piggott, S. 1947 A new prehistoric ceramic from Baluchistan. Ancient India, No. 3, pp. 131-42.

53. Piggott, S. 1950 Prehistoric India. Pelican Books.

54. Piggott, S. 1961 The Dawn of Civilization. Ed. Thames & Hudson, London.

55. Fairservis, W.A., Jr. 1959 Archaeological surveys in the Zhob & Loralai Distts. West Pakistan. Anthrop. Papers, Amer. Mus. Nat. Hist. Vol. 77, pp. 277-447.

56. Fairservis W.A., Jr. 1959 Archaeological studies in the Seistan Basin of S.W. Afghanistan & eastern Iran. Anthr. Pap. Amer. Mus. Nat. Hist., Vol. 48, Part I, pp. 1-128.

57. Fairservis, W.A., Jr. 1962 Preliminary report on the prehistoric Arch. of the Afghan-Baluchistan Areas. Ame. Mus. Novitates. No. 1587.

BIBLIOGRAPHY

Allchin Bridget	1959	The Indian Middle Stone Age : Some new sites in Central Southern India and their implications. Bulletin Lon. Univ. Instt. of Arch., No. 11, pp. 1-36.
Ancient India	1946-65	Edited by Director General of Archaeology, New Delhi. No. 1-21.
Cammiade, L.A. & Burkitt, M.C.	1930	Fresh light on the Stone Ages of south-east India. Antiquity, Vol. IX, pp. 327-339.
Chakravarty, S.N.	1944	An outline of the Stone Age in India. J. Roy, Asiatic Soc. of Bengal, Vol. X, pp. 81-98.
Childe, V.G.	1944	Archaeological ages as Technological Stages, J. Roy, Anthrop. Instt., Vol. LXXIV, pp. 7-24.
Childe, V.G.	1953	New light on the most ancient East.
Clark, J.G.D.	1957	Archaeology and Society, London.
Dani, A.S.	1960	Prehistory and Protohistory of Eastern India. Firma K.L. Mukhopadhyay, Calcutta.
Daniel, G.E.	1943	The Three Ages. Cambridge.
de Terra, H., de Chardin, T. and Hawker, T.C.	1934	Palaeolithic Industries in the North-west Punjab and Kashmir and their geological significance. Memoirs of Connecticut Acad. of Sc. and Art. Vol. VIII.
de Terra, H. & Paterson, T.T.	1936	Studies on the Ice Age in India and associated human cultures. Carnegie Instt. of Washington, Publication No. 499.
Fairservis, W.A., Jr.	1961	Archaeological Studies in the Seistan basin of South-western Afghanistan and Eastern Iran. Anthr. Pap. Amer. Mus. Nat. His., Vol. 48. Part I, pp. 1-28.

Fairservis, W.A., Jr. 1962 Preliminary report on the prehistoric archaeology of the Afghan Baluchi Areas. Amer. Novitates No. 1587.

Foote, R.B. 1866 On the occurrence of Stone Implements in various parts of Madras and North Arcot Distts. Madras J. of Litt. and Sc. III.

Foote, R.B. 1894 On prehistoric man in the old alluvium of the Sabarmati river in Gujarat, Western India. Records of the Br. Ass. for the Advancement of Sc.,p.64.

Foote, R.B. 1914 The Foote collection of Indian prehistoric and protohistoric antiquities. Madras.

Foote, R.B. 1916 The Foote collection of Indian prehistoric and protohistoric antiquities in the Govt. Museum Madras. Notes on their ages and distribution.

Gordon, D.H. 1950 Stone Age Industries of the Holocene in India and Pakistan. Ancient India, No. 6, pp. 64-90.

Gordon, D.H. 1958 The prehistoric background of Indian Culture. N.M. Tripathi Pvt. Ltd., 164 Princess St., Bombay-2.

Hawkes, J., Hawkes, L. & de Terra H. 1934 Yale North India Expedition. Palaeolithic human Industries in the northwest Punjab and Kashmir and their geological significance. Memoirs of the Connecticut Academy of Arts and Scs., New Haven.

Howells William 1954 Back of History. Doubleday & Co. Inc. Garden City, New York.

Indian Archaeology—A Review 1953-64 Edited by A. Ghosh, Director General of Archaeology, India.

Knight, C.R. 1949 Prehistoric man. Appleton-Century-Crofts Inc., New York.

Krishna, M.H. 1942 Prehistoric Deccan. Presidential add. Anth. & Arch. Sect. Proc. of the Ind. Sc. Cong.

Krishnaswami, V.D. 1938 Prehistoric man round Madras. Ind. Acad. of Scs., Madras, No. 3, pp. 32-35.

Krishnaswami, V.D. 1947 Stone Age India. Ancient India, No. 33, pp. 11-57.

Krishnaswami, V.D. *et al* 1951 Microliths of Tinnevally, South India Proc. Ind. Sc. Cong., Calcutta.

Krishnaswami, V.D. 1953 Progress in prehistory. Ancient India, No. 9 (Silver Jubilee number), pp. 53-79.

Krishnaswami, V.D. 1959 The Neolithic pattern of India. Pres. add. 46th Sc. Cong. Anth. & Arch. Sec. Delhi, pp. 124-49.

Krishnaswami, V.D. 1960 The Neolithic pattern of India. Ancient India No. 16, pp. 25-64.

Lal, B.B. 1950 Explorations and Excavations. Archaeology in India. Ministry of Education, Publication No. 66, New Delhi.

Lal, B.B. 1954 Palaeolithic Industries of the Indian sub-continent J. World History, Vol. 1, No. 3.

Leakey, L.S.B. 1960 The Origin of the Genus Homo—in Sol Tax Ed. Evolution of Man, Vol. 2, pp. 17-32.

Leroi-Gourhan, A. 1957 Prehistoric Man. Philosophical Library, New York.

Mac Curdy, G.G. 1935 The Coming of Man. The Univ. Soc. Inc., New York.

Misra, V.N. 1962 Problems of Terminology in Indian prehistory. Eastern Anthropologist, Vol. XV, No. 2, pp. 113-124.

Piggott, S. 1950 Prehistoric India. Pelican Books.

Pilgrim, G.E. 1905 On the Occurrence of the Elephas Antiquus in the Godavari alluvium. Records of the Geological Survey of India, Vol. XXXII, pp. 199-218.

Richards, F.J. 1933 Geographical factors in Indian Archaeology Ind. Antiquary. Vol. LXIII, pp. 235-253.

Sankalia, H D. 1946 Investigations into the Prehistoric Archaeology of Gujarat, Baroda.

Sankalia, H.D. 1952 The Godavari Palaeolithic Industry. Deccan College monograph series 10, Poona..

Sankalia, H.D.	1956	The microlithic Industry of Langhnaj, Gujarat. J. Guj. Res. Soc. No. 4, pp. 275-284.
Sankalia, H.D.	1956	Animal fossils and Palaeolithic industries from the Pravara Basin at Nevasa. Ancient India No. 12, p. 35.
Sankalia. H.D. *et al*	1958	The excavations of Maheshwar and Navdatoli, pp. 35-41. Poona and Baroda.
Sankalia, H.D.	1962	Indian Archaeology Today. Asia Publishing House, Bombay.
Sankalia, H.D.	1962	Prehistory and Protohistory in India & Pakistan. Univ. of Bombay.
Sankalia, H.D.	1964	Stone Age Tools : Their Techniques and Functions.
Sen, D.	1957	The Soanian and the Pebble Tool Terminology.
Subbrao, B.	1958	The personality of India. M.S. Univ. Archaeology series No. 3, Baroda. 2nd Ed.
Wheeler, R.E.M.	1959	Early India and Pakistan. Thames and Hudson, London.
Zeuner, F.E.	1958	Dating the Past. 3rd Ed. Metheun & Co., London.
Zeuner, F.E.	1959	The Pleistocene Period. 3rd Ed., London.

PART TWO

1

What was Harappa Civilization

DISCOVERY

While about a century back, no one knew of the existence of the prehistoric man in India, half a century ago none knew of a great civilization that had existed over the north-western region of the Indian subcontinent. So much so that the history of India then began with the times of the Buddha around sixth century B.C.

The first site of this great civilization was discovered at Harappā in Punjab in 1921. Sahni[1], a member of John Marshall's team, discovered stone seals bearing some inscriptions and animal designs from a trial excavation at this site. These seals were similar to these obtained by Cunningham[2] from workmen who were excavating this site to pull out bricks for laying the nearby railway line in 1861, since which time this site had vaguely been recognized to be a site of an ancient culture.

At about the same time (1922), at another site about 400 miles from Harappā, archaeological excavations were being conducted by Bannerjee[3] around the old dried-up channels of Beas and the Indus at Mohenjo-daro in Larkāna district of Sindh. He was trying to locate the 12 stone pillars said to have been erected by Alexander on the eve of his departure, abandoning his long cherished plan of conquerring India. Bannerjee accidentally came across a big mound where he discovered a flint stone knife. So he suspected that an ancient site was lying buried underneath the mound. Digging the upper parts of the mound revealed only a Buddhist monastery. But during these excavations he discovered some more ancient relics including engraved seals similar to those discovered by Cunningham in 1861 and by Sahni in 1921 at Harappā.

Harappā thus became the first and Mohenjo-daro the second, to be discovered as the sites of this great civilization in India.

Excavations at Mohenjo-daro and Harappā continued with some interruptions for several seasons; at Mohenjo-daro[4] from 1922 to 1931 and at Harappā[5] from 1920 to 1921 and again from 1933 to 1934. Between 1945 and 1948, Wheeler's[6-8] excavations at these sites revealed further useful material.

Another major site of this civilization was discovered at Chauno-daro in Sindh in the year 1935 by Mackay[9]. Mackay was later incharge of the excavation at Mohenjo-daro[10] in 1935-36 also.

After the coming into being of Pakistan in 1947, Indian archaeologists found many more sites of this civilization in Punjab, Uttar Pradesh, Saurāshtra, Rājasthan etc. Of these sites Lothal and Rangpur in Saurāshtra and Kālibangan in Rājasthan are most important. They have shown interesting archaeological evidence of the eastward expansion and later the decline of this civilization.

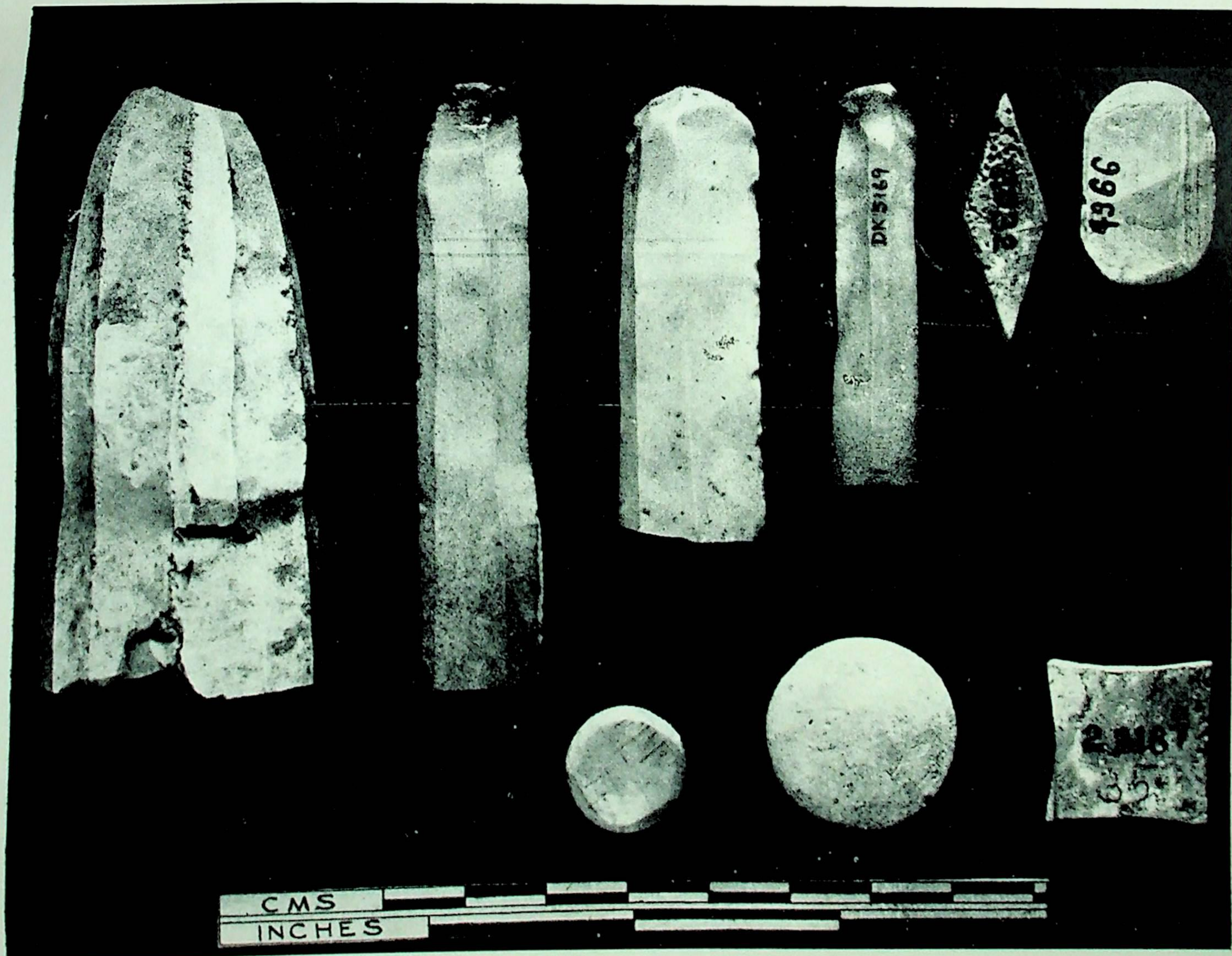
As the first evidence of the existence of this vast civilization was obtained at Harappā in Punjab, according to archaeological conventions, it has been given the name of Harappā civilization. Initially it was tentatively called as the Indus civilization.

CHARACTERISTICS

Excavations at Mohenjo-daro and Harappā and later at other sites, revealed a highly developed urban civilization organized in cities and towns whose wealth was derived mainly from agriculture and trade.

The cities were well-planned and had straight wide streets. Burnt-bricks were used for all sorts of construction work. The residents seem to have enjoyed a degree of comfort, luxury and hygienic environments not obtained in any other part of the world at that time. There seems to have been an effective civil administration and government which controlled the activities at both the major cities, Harappā and Mohenjo-daro.

Good drainage system and numerous baths and wells discovered



Harappā Chert Blades and Shell Objects

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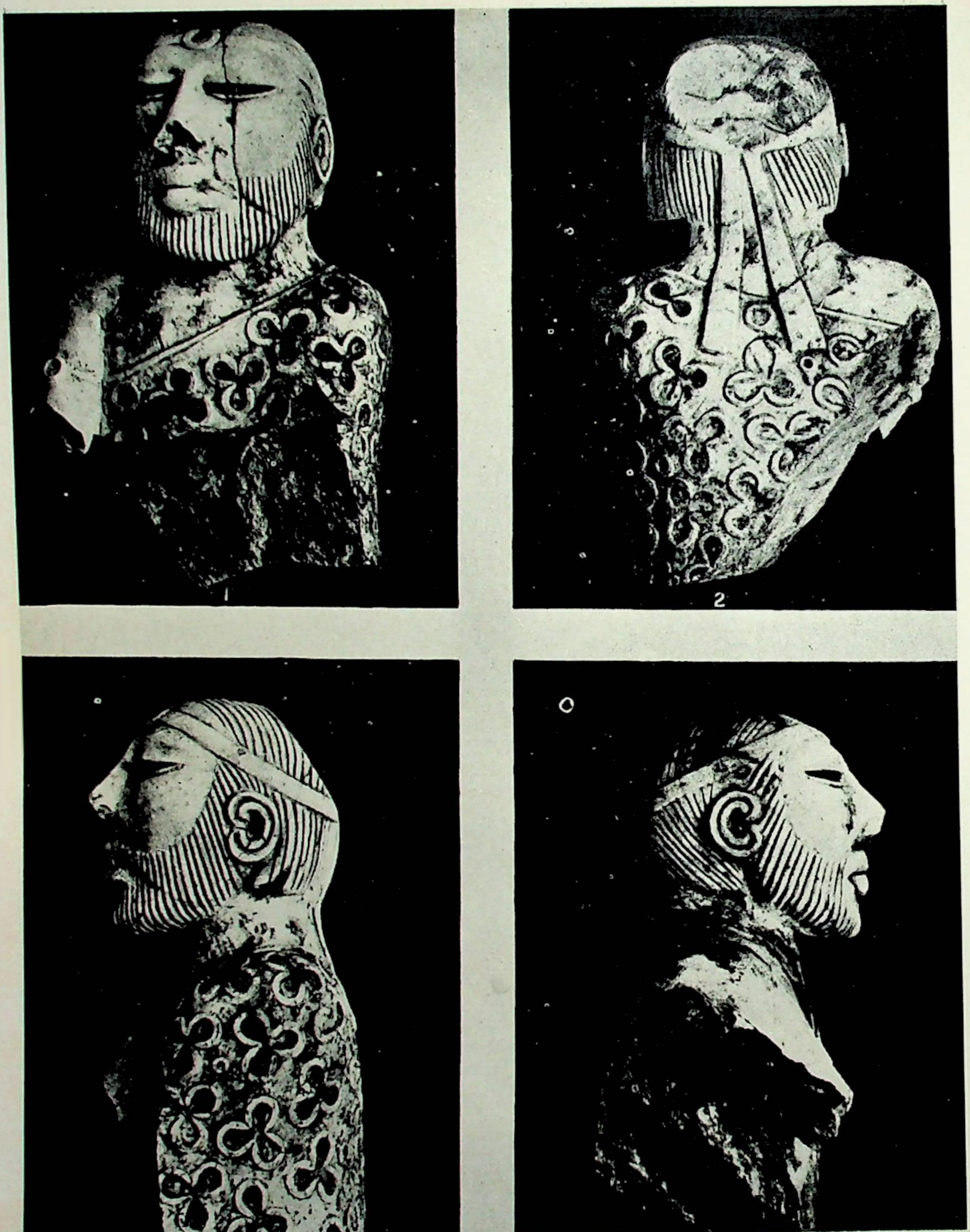

Stone Statue, Mohenjo-daro

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from there, go to show the attention given to water-supply and its disposal. The Harappāns domesticated cattle, sheep, pig, dog and camel etc. For transport they used wheeled vehicles. They were expert metal workers. They had enough supply of gold, silver and copper. Lead too and tin were used by them, the latter being used only as an alloy in the making of bronze. With spinning and weaving of cotton and perhaps wool also, they were well-versed. Their weapons were bow and arrow, spear, axe, dagger, mace etc. They did not have defensive body armour. Among their other implements were sickles, saws, chisels, razors, chert blades, knives and celts made of copper, bronze and stone. Their domestic utensils were chiefly made of pottery turned on the wheel and not infrequently painted over with designs. Copper, bronze and silver was also used for making such utensils. Ornaments of the rich were made of silver, gold and copper, sometimes overlaid with precious stones, faience, ivory and shell. For the poor they were of shell or terra-cotta. People were literate and used a script which unfortunately has not so far been deciphered.

Engraved figures on the seals, and the terra-cotta and pottery statues recovered from these sites show the resemblances of these figures to the later gods and goddesses that were worshipped by the Hindus. That clearly indicates Indian character of this civilization.

Uniformity of this civilization, at different sites is striking. Both Mohenjo-daro and Harappā show similar town-planning, buildings, mud-brick ramparts, well-aligned houses, sanitation and other antiquities.

EXTENT

Further excavations, after the discovery of Harappā and Mohenjo-daro, revealed scores of large and small sites belonging to this civilization. Many of these are situated along the present course of the river Indus and the foot-hills of the Kirthar range. Chauno-daro about 80 miles south-east of Mohenjo-daro, Amri the same distance downstream from Mohenjo-daro, Lohumjo-

daro, Ali Murād, Jhukar, Ghazishah Alor etc. on the western bank of the Indus, are some of the other principal sites in Sindh. Further west, Aurel Stein's[11] explorations proved the extension of the Harappā civilization to Dabar Kot, Sur Jangal and Periano Gundhal in north Baluchistān and Kulli and Mehi in south Baluchistān. A little more than 300 miles west of Karachi and just 25 miles from the shore of the Arabian sea, a site known as Sutkagen-dor appears to have been a fortified outpost of this civilization.

To the east of Harappā, the first site of this civilization was excavated at Chak Purbāne Syal[12] on the old deserted bed of Beās river, about 13 miles south-east of Harappā. Other sites excavated were at Rupar on Sutlaj, and Kotla Nihang Khan near Rupar[13]. Objects belonging to Harappā civilization found at Ghazipur, Benares, Buxar and Patliputra (Patna) indicate the influence of this civilization at these sites also.

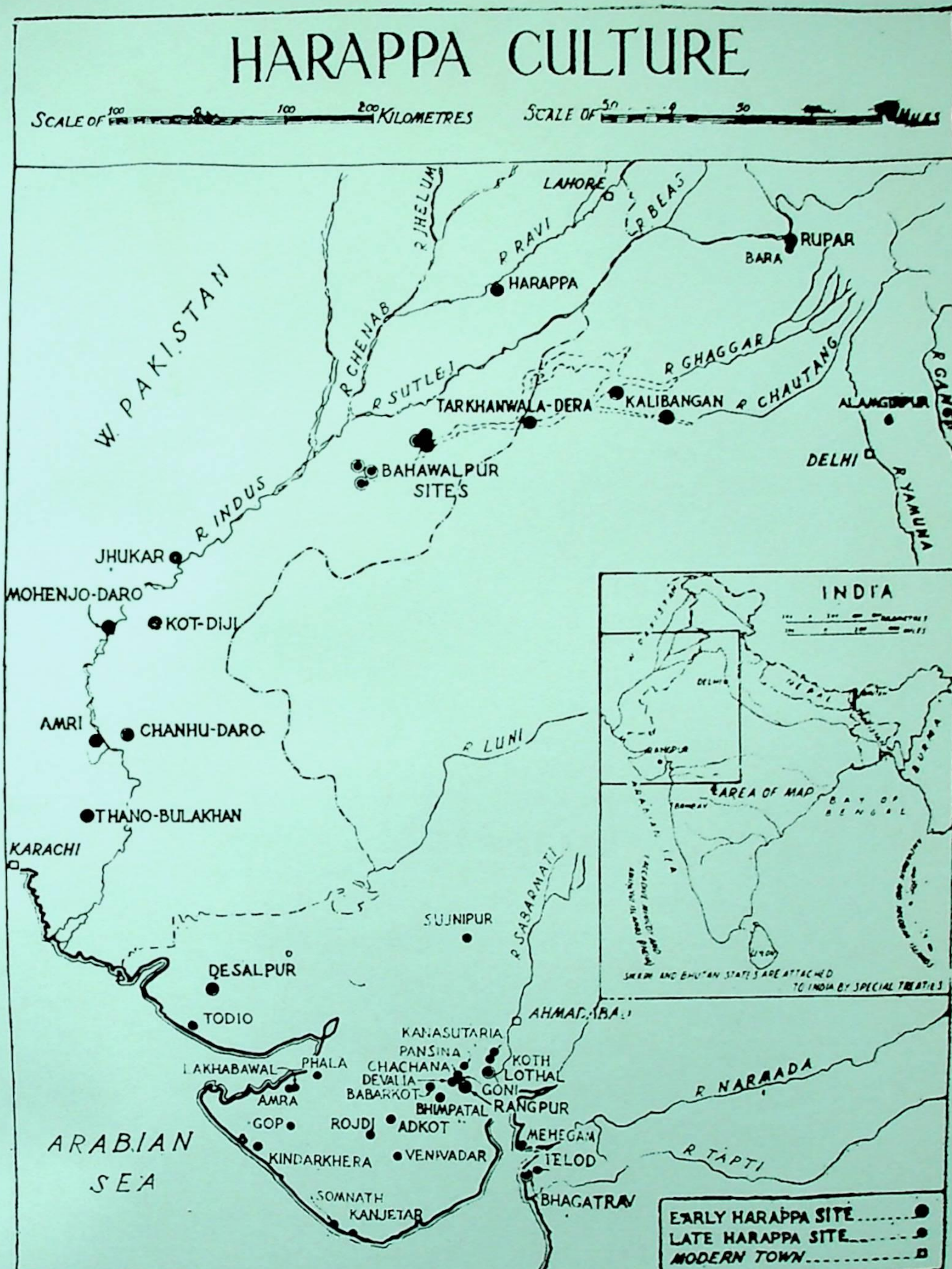
During the past 10 years many more sites have been located in East Punjab, Uttar Pradesh—one of them very near Delhi at Alamgirpur in Meerut district, in Rājputanā, Kutch and almost all over Saurāshtra at Rangpur, Somnath, Prabhās, Lakha Bawal, Amra, etc. and at Lothal and many other sites in central and southern Gujarāt.

Thus we see that the Harappā civilization occupied the whole of Sindh, Punjab, North West Frontier Province, a part of the Gangetic basin, Saurāshtra, Gujarāt and other western coastal regions. This civilization, as discovered so far, seems to have occupied $1{,}200 \times 700 = 8{,}40{,}000$ square miles area—which in size is very much larger than even the combined areas of the ancient civilizations of Mesopotamia and Egypt put together.

OUTSIDE INDUS VALLEY

Recent archaeological excavations reveal the story of the east and south-ward spread and later decline and destruction of the Harappā civilization.

The first Harappān settlement near the gulf of Cambay was



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made at Lothal.[14] It seems to have been contemporary with the cities of Harappā and Mohenjo-daro. It is possible that the settlers came here from the Indus valley sites and to reach up to Lothal they took the sea route. Many temporary settlements along the western coast indicate this possibility. Lothal at the time, was not just a mere trading centre but a full-fledged port town which owed its prosperity to trade with other overseas countries.

Recurring floods in the neighbouring rivers seem to have been a great menace to this town. One of such floods around 2000 B.C. seems to have forced the residents of Lothal to move farther interior to Rangpur, Koth, to the south of the gulf of Cambay at Bhāgatrav in the Kim estuary and towards north at Desālpur in Kutch.

It seems that even though the people here devised several measured to save their townships from floods, they could not withstand the onslaught of the second great flood in some of the rivers of Kutch and Gujarāt around 1500 B.C. Ultimately when the floods receded, the inhabitants returned to their settlements at Rangpur and Lothal. The town of Desālpur however, remained abandoned.

Similar floods seem to have occurred at the same time in the Indus valley also which forced the residents to leave their hearths and homes and to move along the coastal areas into Gujarāt and Mahārāshtra. The Harappāns from the Indus valley thus moved out in two waves, the pioneers around 2000 B.C. and the refugees around 1500 B.C.

The refugees having lost everything had to start from the scratch. They lived in poorer conditions for a fairly long time. During those days of unsettled life they could not think of all the material comforts they once enjoyed. They could not import raw-materials such as chert, steatite etc. and lived in small villages depending mostly on agriculture and cattle-breeding. Hence the refugee settlements were small with mud brick houses where no drains or brick-paved floors existed. Even the reoccupied towns such as Lothal and Rangpur shrank in size to a very large extent.

The houses were shabbily constructed, more on the lines of an ill-planned village than a large well-planned town.

In course of time, the refugees moved from the small coastal settlements towards the plains and hills in the peninsula and finally reached the mainland. They also enlarged their villages into small towns, wherever they continued to live on for a long time. It is during this phase that they were migratory folk, coming in contact with other culture groups and borrowing occasionally a new ceramic type or a painted motif. They had to adopt themselves to new circumstances. New shapes of pottery and utensils thus evolved. Their stone tools were made of the local raw material. They used short parallel-sided blades of chalcedony instead of flakes of chert. At Rangpur and Devaliya where chert was not available, Jasper and agate were used for making scrapers instead of the blades. In the absence of steatite, terra-cotta and agate beads analogous in shape and finish to the steatite and faience beads of the earlier times, were used for personal decoration. Spheroid weights of granite or dolerite which were in use in the earlier period continued to be in use later too, but the cubical weights of agate and chert disappeared owing to non-availability of the material. There was, however, no radical change in the standard of weights.

Thus it is evident that even though the Harappān sites were destroyed by natural calamities, the Harappān culture survived all over Gujarāt, Mahārāshtra and in parts of the Indo-Gangetic basin and in the process it exchanged and adopted ideas with the other existing cultures in these areas.

ITS AGE

This has been calculated variously, depending upon the nature of the material utilized by the scholar for determining it.

Excavations : At the time the cities of Mohenjo-daro and Harappā were discovered, John Marshall was very enthusiastic about the great antiquity of this culture. His excavations at Mohenjo-daro had brought to light seven different layers of buildings and there were still others which were submerged in the

subsoil water and so could not be reached. He tentatively assumed these different occupation layers to belong to a period between 3250-2750 B.C.

Seals : Seals characteristic of the Harappān civilization were also discovered at Elam and Mesopotamia. These seals helped in dating the Harappān civilization because the foreign sites from where they were discovered had already been dated fairly accurately. Two of these seals, according to Marshall[15], could be assigned to pre-Sargonic period of not later than third millennium B.C. and two others found at Ur and Kish perhaps belonged to an age before 2800 B.C. Marshall, however, qualified his these statements with the remark that the various seals excavated at Mohenjo-daro are of the same style from different levels of excavation so that the specimens found at Ur and at Kish might equally well have been produced in the Late, Intermediate or Early period of the Harappā civilization and one could not be so sure of their age. He, howevei, assumed that the seals from these sites belonged to the Intermediate period of the Harappā civilization.

Wheeler[16], on the other hand, said that the maximum period required to cover the seals discovered at Ur, Kish etc. would be between 2500 to 1500 B.C., with a strong focus on 2350 B.C. He said that of the twelve seals for which dates can be postulated, one is pre-Sargonid, seven are Sargonid (2350 B.C.) and four are of still later periods.

Carbon-14 Dating : Carbon-14 date of the charred wheat grain particles discovered at Mohenjo-daro has been shown to be 1760 ± 115 B.C.[17]

Fairservis[18] estimated the limits of the Harappān civilization to be between 2100-1200 B.C.

Over-all Assessment : In the midst of these conflicting dates assessed on the basis of different objects of the Harappān civilization recovered at various sites, it is necessary to remember that at the moment the Harappan civilization is revealed to us at the two major cities, it is already fully developed. It is reasonable to postulate for it a long period of evolutionary development. The complexity of the city life, the elaborate nature of its buildings,

excellence of its arts and crafts, its pottery with different shapes which must have passed through long development, the beauty of some of the seals and the generations of efforts it must have involved to bring them to that perfection, the conventionalized signs of the Indus script, all these could only have resulted from long centuries of previous endeavour. Even if we assume that some of the techniques were imported ready-made yet the very characteristics of the Harappān civilization which are different from any other ancient civilization show that the beginnings of the Harappān civilization must have been much older than the seals discovered at various foreign sites or the carbon-14 dates of various articles could indicate. At the moment one can only say that the beginnings of the Harappā civilization can be traced to the second half of the third millennium B.C.

Regarding the date of its end, considering the wide extent of this civilization in space, one cannot accept any single arbitrary date for the whole civilization. It looks that the Harappān civilization survived in the peripheral zones of Baluchistān, Western Rajputanā and Saurāshtra for a much longer time than at its epicentre. With the excavations at Lothal, Rangpur, Somnath, Amra, Lakhabawal, we have very good reasons to believe that this civilization survived in a pure form for a longer time and continued in a decayed state with new elements entering into it right upto about 500 B.C.[19]

BEGINNINGS

A remarkable feature shown by the excavations at Kot Dijian[20] in Baluchistān, is the occupation of this site for 16 times, one on top of the other, at different times. Three layers at the top are characterized by the Harappān pottery and other objects. The fourth layer reveals both the Harappā and the pre-Harappā material. The fifth layer has objects in it quite different from the layers above it, and seems to belong to an earlier culture which has now been labelled as Kot Dijian and has been dated around 2400 B.C. In this layer, we find evidence of looting and con-

flagration of the property and belongings of the people. All the layers below this, belong to cultures that come between Kot Dijian and that of the peasant communities of the Baluchistān region. The thirteenth layer from the top or the third one at the bottom has been given carbon-14 date of 2700 B.C.

From the above findings, it can be inferred that the early dwellers of the Indus valley were the children and grand-children etc. of the people who were hunter-farmers of the Neolithic peasant communities of Baluchistān. They had come down in the Indus valley beginning around 3000 B.C. In the middle of the third millennium B.C. there came another set of people (fifth layer) again from Baluchistān who looted the existing people of their belongings and burnt their settlements. They afterwards lived there, built their own settlements and established their culture. They were culturally more advanced than the people whom they suppressed. They made copper and bronze weapons and implements.

Whether they were the same people who subsequently built the Harappān civilization cannot be said with certainty. One thing, however, is clear that the most important thing that they or some other people of this area brought with them, was the idea of creating a city civilization, which given optimum environments flourished into the Harappān civilization. People living in the hilly areas of Baluchistān at the time were perhaps aware of the city societies to their west in Mesapotamia, but due to their local difficult and precarious existence in the hills they could not profit by this knowledge. When the same people entered from the hills into the valley of Indus, in the vast fertile areas where the communications were relatively easy because of the river transportation, they saw their opportunity and created a city-society.

The people who established the Harappā civilization could not be the colonists from the already-developed civilization of Sumer and Mesopotamia. Because even though there are some similarities between the two cultures yet the fundamental differences between them are really too vast.

DESTRUCTION OF CITIES

Floods : Repetitive floods and increasing poverty of the people were certainly two, amongst other factors. In the city of Mohenjo-daro a marked degeneration in civic standards has been observed in its later phases. Everywhere the houses mounted gradually upon the remains of the previous ones or on the platforms of unbaked bricks which helped temporarily to raise them above the level of floods. Even these houses were partitioned into smaller ones to accommodate people of poor economic status. Streets and lanes were encroached upon by shoddy structures or even by kilns, which in better times had completely been banished from the residential areas.

Invasion : Over and above this decline in the standard of the life in the cities, there is evidence in the topmost layers of Mohenjo-daro that men, women and children were massacred in the streets and houses and were left lying there, or at best crudely covered over. Similar evidence of burning, looting and massacre from other areas such as Baluchistān, other parts of Sindh and the Punjab indicates that at some time a round 1500 B.C. the long-established cultural traditions of the north-western Indian subcontinent were rudely and ruthlessly shaken by the arrival of a new set of people from the west. The defensive walls excavated from around these cities indicate the protective measures taken against the invaders, but they proved inadequate, particularly as this came about at a time when the Harappān civilization had become weakened from within as well. Inhabitants of the city of Mohenjo-daro and Harappā left their houses and fled towards east into the Punjab, the Gangetic basin and beyond and also along the western coast to Gujarāt and Saurāshtra.

RIG VEDIC ACCOUNT

The above archaeological evidence of the destruction of the cities has been shown by some scholars[21] to fit well with the tale of conquest recorded by the Aryans in their religious scripture, the

Rig Veda. The 'Dasyus' and 'Dasas' mentioned therein, with their dark skins and flat noses are said to be the inhabitants of Mohenjo-daro and Harappā who were conquered by the Aryan-speaking people. The forts of the 'Dasyus' and the 'Dasas', as mentioned in the Rig Veda, were the massive fortifications around the cities that have been partially excavated. These forts or fortifications were wrecked by the Aryan Lord Indra, the most powerful destroyer of these forts, as is mentioned in the Rig Veda.

Further archaeological studies suggest that the people who used Grey pottery and so are called as Grey Ware Folk destroyed the Harappāns and were instrumental in the fall of the Harappān civilization.

Correlating the above different views, Ghosh[22] remarked "that while it is admittedly premature to hold that latter people (Grey Ware Folk) were no other but the Aryans, it is doubly premature to say that the Aryans had nothing to do with the disappearance of the Harappāns".

HARAPPA VIS-A-VIS VEDIC CIVILIZATION

The following points indicate the dissimilarities between the Harappān and the Vedic civilizations.

1. Harappā was an urban civilization, as is witnessed at Mohenjo-daro and Harappā, which had large populations properly housed in brick-made buildings with good sanitation and other essential amenities. Vedic age people were agricultural-cum-pastoral. They were not conversant with cities or city life and their houses etc. were temporary structures. They still belonged to village communities.

2. Harappān people used bronze, copper, silver and gold for their implements, household utensils and ornaments. They were, it looks, unfamiliar and unaware of iron. On the other hand, there is evidence to show that Vedic age people, at the time of Yajur-Veda and Atharva Veda, used all these metals plus iron as well.

3. Harappān people used weapons such as bow and arrow, spear, dagger, axe, mace etc., all weapons of offence. There is no

evidence to show that they had any defensive weapons or body armour. Vedic people, on the other hand, were familiar with body armour and used that in self-defence. (It is possible that this lack of defensive weapons was one of the factors that led to the fall of the Harappāns in the battle-field).

4. Fish, molluscs, turtles have been shown to have formed part of the diet of the Harappāns while Vedic people were meat-eaters and the Vedas make no mention of the use of fish as an article of diet.

5. Harappāns were, in all probability, not aware of the existence or the use of horse while Vedic people were.

6. Harappāns gave importance to the bull while the Vedic people worshipped cow.

7. Harappān religion was iconic and phallic worship was part of it. Vedic people, on the other hand, were an-iconic and they did not indulge in phallic worship.

All these above points and many more, show that the Harappan civilization was quite different from the Vedic.

WHICH PRECEDED-HARAPPAN OR VEDIC ?

This question has not yet been settled to the satisfaction of every body. Some people have put forward views that Vedic age preceded the Harappān. Sastri[23], wrote that "Indus civilization was in all probability contemporary with the Atharvan age". Sankarananda Swami[24], wrote that, "The builders of the Indus Civilization were the Vedic Aryas". Ramachandaran[25] identified the Indus valley civilization with the Aryans.

Contrary to the above views—and in spite of there being some logic in the development from the village culture of the Vedic civilization to the city culture of the Harappāns—there is the fact of the knowledge of iron and its utility which the Vedic people had but not the Harappāns. If the Vedic civilization occurred earlier than the Harappān then the latter should also have known and used iron. But as we know that is not so. Secondly how is it that the cow was venerated by the Vedic people and after that the bull

became important in the Harappān period and then again the cow regained its position. The plausible explanation seems to be that the bull was the object of importance to the Harappāns but after them in the Vedic period and in latter times, cow became sacred to the people.

Thus we see that *the evidence available at present* suggests that the Harappān civilization is older than the Vedic.

CONTACTS WITH OTHER COUNTRIES

With Mesopotamia: The Harappān culture is inherently different from the ancient Mesopotamian culture and yet there are certain resemblances between them. Both were city civilizations and had similar construction of buildings. They used copper and bronze for their utensils, ornaments, weapons and implements. Both used pottery made on the wheel and had wheeled vehicles for transport. Besides these, many objects of the Harappān make were recovered from Mesopotamian sites and vice-versa. All this indicates that there existed contacts between the Harappān and the Mesopotamian civilizations. There are indications also to show that these contacts were maintained both by sea as well as by land routes as early as 2500 B.C.

There are some points of difference between the two cultures as well. These look to have been due to different local conditions. The use of true arch in the construction of buildings etc. is found only at Mesopotamian sites while it is the corbelled arch in the Harappā civilization cities. This variation is explained by the fact that a corbelled arch requires strong well-burnt bricks which in the sparsely-wooded Mesopotamian cities were not available and hence the people felt the need to invent the technique of making a true arch. At the Harappān sites strong burnt-bricks were available in abundance so that a corbelled arch could be built with ease. Similarly round columns for support of buildings are found at the Mesopotamian sites but not in the Harappān because here big trunks of the trees could easily be used for this purpose.

With Egypt: Not a single object that can definitely be said to be of Egyptian workmanship has yet been found at Mohenjo-daro and Harappā. Vice versa also holds true. Certain objects and motifs, however, do suggest an indirect communication between them perhaps through other countries. It is well known that during a considerable part of her early history, Egypt was acquainted with Red sea and Somali coasts and it was never difficult for the Indians to reach these places from the north-west of India.

With Baluchistan: Northern Baluchistān sites such as Dabar Kot, Sur Jangal and Periano Ghundal and southern ones such as Kulli and Mehi-damb were in direct contact with the Indus valley. Number of objects and pottery pieces found at these ancient sites in Baluchistān can be closely related with similar objects and pottery at Mohenjo-daro. These settlements in Baluchistān must have been of a lot of interest to the people of the Indus valley as they were along the land trade route with the west.

IMPORTANT HARAPPAN SITES

MOHENJO-DARO

Mohenjo-daro is situated in the broad plains of the Larkanā district between the river Indus and the Kohisthān or Kirthar hills. Its precise position is 27° 19′ N by 68° 8′ E, about 7 miles by road from Dokri on the North-Western Railway and 25 miles from Larkanā town.

When first discovered, the ancient ruins at Mohenjo-daro were just a few mounds, mostly 20-30 feet high, the highest being 70 feet high. Area covered by these mounds was approximately 250 acres. Originally the area occupied seems to have been much larger but repeated floods washed it away and whatever the floods could not level down, they cut through forming the present mounds of different sizes. These mounds are divisible into two parts; the one at the higher level is called the 'citadel' and the others situated to the east of the citadel and at a lower level 'the city'.

The 'citadel' is built on a 40-feet high platform made of mudbricks and mud. This was intended to raise the level of the buildings so as to protect them from the recurrent floods. This platform belongs to the Intermediate period of Mohenjo-daro's growth. Beneath this were discovered six or seven phases of the earlier development of the city. At one corner of the citadel was discovered a part of thick wall and a tower made of burnt bricks, which might have been used for defensive purposes. Of the important buildings excavated from the citadel is the great bath or tank and its adjacent structures and a granary, detailed discription of which is given in a later chapter.

Basic plan of the city of Mohenjo-daro seems to have been based on, 'the main streets running north-south and east-west dividing the rectangular area of 800 feet east to west and 1200 feet north to south into blocks of roughly equal size. If the layout indicated by the central street plan was extended symmetrically there would be a square city a mile across comprising 12 major building blocks in three rows of four, east to west[26]. The main streets of the city are about 30 feet wide and the blocks are subdivided by lanes which are usually 5 to 10 feet wide and it is towards them that the houses open.

Windows as such in the walls of the houses are rare. Domestic life seems to have centred around the courtyard. Some houses have a seat-latrine built on the ground or on the first floor with a sloping and occasionally a stepped channel through the wall which ends in a pottery receptacle or a brick-drain in the street outside. The larger buildings in Mohenjo-daro are perhaps palaces, temples or inns for the travellers and the smaller structures are the shops.

The streets in Mohenjo-daro are generally unpaved. They have brick-drains so nicely laid out that they are without parallel in any other part of the world of those days. Water supply was obtained from innumerable public and private wells. Everywhere there is clear evidence of controlled well-developed urban layout and sanitation.

Decline in the living standard of the people of the city is

witnessed by the poor construction and bad sanitation on the top layers of the excavated city as compared with the lower ones which belong to the Intermediate phase. It looks that as the population increased, the peripheral expansion of the city being not possible due to the danger of floods at the lower levels, the earlier larger houses were divided and subdivided. This provided more accommodation but caused a serious damage to drainage and sanitation. Excavations have shown that during the last phases of the city, a whole big chunk of the city, which previously was a residential area, was occupied by artisans and potters who made their kilns inside the city.

It is difficult to say how long the city of Mohenjo-daro flourished but a guess is that it might have been for about 300 years. Though now generally a dry area, at the time when Mohenjo-daro flourished, it looks to have had lot of rain, vegetation and trees. This is shown by the kind of animals on the engraved seals and the use of burnt-bricks which certainly would have required large quantities of timber. On river Indus depended the prosperity of this city for agriculture, irrigation and also for transport.

HARAPPA

Ancient ruins in the form of 25-60 feet high mounds at Harappā on the river Ravi in Montgomery district of the Punjab were noticed for the first time by Cunningham in 1862-63. They covered an area about two and a half to three miles in circumference.

When Lahore-Multan railway line was laid in the later half of the last century, burnt-bricks from these ancient mounds were removed indiscriminately and were used to lay the railway line. Most of the ancient structures were thus uprooted in the process. Whatever was left behind was used by the people living at Harappā at the time, to build their own houses. The result of all this pilferage was that many initial attempts at archaeological excavations revealed nothing significant from the site. Further excavations, however, brought to light a few interesting findings

and also helped to check and amplify those of Mohenjo-daro.

Main feature of the plan of Harappā is the 'citadel' on the west and the mounds of the 'lower city' towards the east and south-east.

The citadel is roughly a parallelogram 460 yards from north to south and 215 yards from east to west. The buildings here are constructed upon a platform of mud bricks and mud, to raise and protect them from the onslaught of the floods. Around the citadel is a massive defensive wall 45 feet wide made of baked bricks which has at frequent intervals rectangular bastions or towers.

On an other mound close to the mound of the citadel, a few important structures have been excavated. One of them is the building of a granary. This is so exquisitely designed that it has no parallel anywhere else in the world of those days. Other structures are brick-made circular platforms for pounding grains. Both of these have been described in detail in a subsequent chapter.

Of the remaining structures excavated at Harappā no intelligible plan can be made out.

Hari-Yupuya: There is mention of a place named Hari-Yupuya[27] in Rig Veda. At this place in a battle Vrśivants are said to have been defeated by Abhyāvartin Sayamāna. The tribe of the Vrśivants has been connected by some scholars with Varśin, who was an enemy of Indra and a non-Aryan. A plausible conjecture has been put forward by some scholars that the present Harappā site is the same Hari-Yupuya mentioned in Rig Veda.

Similarities between the two cities: There are certain remarkable similarities noticed between Mohenjo-daro and Harappā. Both the cities have similar layout. Both the sites are roughly 3 miles in circumference. The mounds themselves at each site fall into two groups, a high mound towards the west and a much more extensive but somewhat lower one to the east. At both the cities, the citadel was a parallelogram, some 400-500 yards from north to south and 200-300 yards from east to west, with the present maximum height of 40 feet. At both the places it was similarly orientated with the major axis north to south. The pottery, weapons, house-hold utensils, ornaments, seals,

weights and measures discovered from Mohenjo-daro and Harappā are all cast in the same mould and are so alike that it is impossible to distinguish between them.

CHAUNO-DARO

Ruins in the form of three large mounds 1060, 950 and 450 feet in circumference and between 12 to 24 feet high, were found at Chauno-daro in Sindh, 80 miles south of Mohenjo-daro. These mounds had been created by recurrent floods but initially it was the site of an Harappān town, by the side of which flowed the river Indus. This river having now changed its course flows about 12 miles away from the site of the ruins.

Excavations at this site undertaken in 1935, 1936[28] revealed five different strata of occupation of the site at different times. The three strata at the bottom of the mounds belong to the Harappān period. The one above the Harappān belongs to a post-Harappān culture called as Jhukar culture, because of its similarity with the culture first discovered at a site called Jhukar in Sindh. The top-most stratum contains elements of yet another post-Harappān culture which came into being after Jhukar and is called Jhangar culture, because the like of it was first discovered at the site called Jhangar in Sindh.

Harappan Period: The three strata belonging to the Harappān culture are separated from one another by the intervening layers of debris and silt. This indicates that the site was destroyed by floods twice and remained unoccupied for sometimes before it was rebuilt. When the site was rebuilt for the third time, all the buildings were built on extensive mud-brick platforms so as to raise their level and to protect them from the floods.

Chauno-daro is built along a 25 feet wide street. The buildings and the drainage system generally follow the structural pattern of Mohenjo-daro, even though this is a smaller and poorer city. The lower stratum of the Harappān period shows better drainage, buildings and other amenities, but in the subsequent two layers there is evidence of decline in the city life.

From the objects excavated from different areas, it appears that most of the inhabitants were artisans and craftsmen. Many bronze or copper implements as well as some objects made out of shell and bone and a few seals, some of them unfinished, were found scattered on the floors in some places.

Jhukar Culture: The Jhukar culture people seem to have occupied Chauno-daro after the Harappāns had left the town. They lived in some of the deserted houses and wherever necessary reconstructed the houses but this construction was very poor in quality. The poorer people amongst them seem to have lived in low-roofed square or rectangular huts whose floors they paved with broken bricks. Their fire-places were made outside these huts.

Characteristic features of Jhukar culture, amongst other things, are the circular seals of pottery or faience, which differ from the square ones of the Harappāns, and the painted wares which in make and style of decoration differ radically from the pottery of the Harappāns. Finding of a large number of bone awls indicates that mat-making was one of their chief occupations. They were on the whole poor people.

Who the Jhukar culture people were, cannot be said with certainty. The date at which they occupied Mound II at Chauno-daro is estimated to be around 1700 B.C.

Jhangar Culture: Topmost stratum at Chauno-daro (Mound II) was occupied by people whose grey or black pottery wares links them with Jhangar culture people.

LOTHAL

Lothal[29], situated in the flat alluvial lowland at the junction of north-east end of Saurāshtra and mainland Gujarāt was discovered as a site of Harappān culture in 1954. Village Saragwāla in which 22-feet high Lothal mound is situated is now included in Ahmedabad district and is about 60 miles to the south of the city of Ahmedabad. Lothal in ancient times was perhaps situated at the confluence of the rivers Bhogāva and Sabarmati. Due to the change in the course of these rivers, this point is now situated

about 2 miles south-west of Lothal. Topographical study shows that in ancient times Lothal was once very near the sea.

Archaeological excavations being conducted since 1955, have revealed two main periods of occupation of this site. Period I had four sub-phases and each sub-phase is distinguished from the other by an intervening layer of flood-borne debris. Period I is calculated to have lasted between 2500 to 1500 B.C., and it shows manifestations of a mature Harappā civilization. Period II between 1500-1000 B.C. shows evidence of decadence of the city.

Though small, about 2 miles in circumference, this Harappān site at Lothal, seems to have been a well-planned town, 'a miniature Mohenjo-daro' with a rampart encircling the main habitation. This town looks to have been divided into six blocks, each built on an extensive platform. Excavations have revealed four streets and on one side of a street is a row of twelve houses. Smaller enclosures measuring $12' \times 9'$ to $8' \times 6'$ on either side of another street seem to have been the shops. A few larger houses measuring $72' \times 42'$ had either verandahs in front or had rooms all around a central courtyard. There is a cemetery outside the rampart at a distance of one furlong in the north-west corner.

A large brick-built enclosure, which now has been recognised to be a dockyard, the first of its kind to be discovered in India or anywhere else, is a unique finding. This dockyard has been described in detail in a subsequent chapter.

From the very beginning, the houses were built on solid mud-brick platforms but every time as the floods caused destruction, these platforms were raised further, as was done at Mohenjo-daro and Harappā also.

Important objects recovered from Lothal include a measuring rod and an object which has been recognized to be a sort of compass for measuring angles. Other finds are a few copper objects including a small dog made of copper, a golden necklace with 50,000 tiny gold beads in it, a few terra-cotta plumb bobs of different sizes with or without vertical rods, bronze drills of the auger-type with twisted grooves in addition to the flanged ones and the needles which had eyelets at the piercing end. A

bead-making factory and a circular kiln have also been discovered.

A circular seal of steatite with two jumping gazelles flanking a two-headed dragon, found at Lothal provides unmistakable proof of trade contact with Bahrain and other islands in the Persian Gulf.

Period II at Lothal is remarkable only for the general decadence. The houses are out of alignment and the drains are haphazardly laid. During this period pottery of new shapes and designs and blades of jasper and agate, instead of those of flint, are found.

RANGPUR[30]

It is 30 miles to the north-east of Lothal and is situated on the Bhadur river, 3 miles from Dhandhuka Railway station in north-eastern Saurāshtra.

Three main cultural periods have been observed of Rangpur. The earliest one shows microliths in the sandy river deposit. Over it is the mature or probably a late phase of the Harappān culture and it exhibits all the characteristic features of this culture, as for example brick buildings, drains, mud-brick fortifications, pottery, ornaments, tools, weapons and weights. Without any apparent signs of destruction by flood, fire or force, there appear in period III new pottery fabrics, shapes and designs. The earlier brick houses give place to those made of mud-bricks. The blades are of jasper and not of flint. During this period new cultural elements seem to have taken a peaceful possession of Rangpur.

KALIBANGAN[31]

It is situated in Gangānagar district in north-western Rajasthān. It is one of the sites which shows both the pre-Harappān and the Harappān cultures.

The ancient ruins here consist of two mounds, the larger one is towards the east and the smaller one to the west. They are separated by a valley between them. Below the mounds about two furlongs away is the dried-up bed of the river Ghaggar which was once known as Saraswati.

The smaller mound is considered to be a 'citadel' and the larger one the 'city'. It was below the citadel that a pre-Harappān settlement was found.

The citadel is made of mud-bricks. It is believed to have contained the administrative set-up of the Harappān empire.

On the bigger mound, a township area has been unearthed with lanes or streets ranging from 6 to 20 feet in width. Each house faces at least two streets and has a rectangular plan consisting of a courtyard often with a well, and six or seven rooms aligned on three sides.

Among the finds from this site are attractively painted and gracefully shaped pottery, ovens, long chert blades, personal ornaments like beads and bangles, household tools of copper and bronze and terra-cotta feeding bowls, toy carts etc.

2

Town-Planning

While large parts of the Indian sub-continent were still passing through the Neolithic stage *i.e.* of the peasant village communities with the people living in primitive shelters, the Harappāns in the north-west had created large and well-planned cities. Mohenjo-daro at the time of the Harappān civilization was a big city. It was divided into many blocks of houses and buildings. It had wide streets, the widest one measured 30 feet. Service lanes that divided one block of houses from the other varied from 3 feet 8 inches to 7 feet in width. Straightness of the streets and the exact alignment of the houses along them is a feature that indicates the superb technical skill of the builders.

A long stretch of the First Street in Mohenjo-daro is paved and the pavement is made of brick pieces and potsherds mixed in clay so that it is very compact. Pieces of bricks used for this purpose can easily pass through a 1.5 inches ring and the potsherds mixed with them are of still smaller size. Other streets look to have been left unpaved.

There is an excellent drainage system in the city of Mohenjo-daro. The drains along both sides of the street and in the middle of the street are all covered over. It was perhaps due to this fact that the streets were left unpaved as that would have interfered with occasional opening and cleaning up of the drains.

There seems to have been provision for providing light in the streets at night as well. At least at two places on the outsides of the buildings, there is space for support of a lamp. A projecting brick in one of the walls of a building with its upper surface slightly hollowed out could very well have been part of a lamp itself.

The most remarkable feature in the building plan of the cities and towns of the Harappā civilization was the care taken to protect them from the floods. High mounds, mud-brick platforms and the use of burnt bricks, all point towards this objective. The Harappāns must have employed other means also to control the floods such as bunds or dams, but at present none of them can be located.

Such layout of the city could only have been possible if the rules of town-planning were known and observed when its foundations were laid and also the new constructions added later on, were supervised by an authority entrusted with this work. This fact may now look to us as commonplace yet it was a very real and remarkable achievement of the Harappāns in those days when in other contemporary civilizations in the west, the houses were located haphazardly along crazily winding streets.

Mohenjo-daro, Plan of Houses

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3
Buildings

A look at the excavated buildings of the city of Mohenjo-daro does not give one the impression that they belong to an ancient city. They are simple yet massive and durable in construction. They are built of accurately made and burnt bricks. Even the houses which seem to belong to the poorer people are built with such bricks. The bricks are laid in mud or mud and gypsum mortar, the latter being used only sparingly. Inner sides of the walls are vertical and are coated occasionally with thick mud plaster. Vertical alignment of the walls in majority of the cases is excellent and this by itself indicates use of a plumb line. The outside walls of the larger buildings are not vertical but have a battering—an intentional slope from above downwards.

The excavated buildings generally fall under two categories—the dwelling houses and the larger buildings. The dwelling houses vary much in size, the smallest ones having just two rooms. The larger buildings might have been palaces of the rich people. Some of the buildings seem to have had upper storeys also which were approachable from the courtyard by means of a staircase.

MUD-BRICK PLATFORMS

The purpose of these platforms was to raise the level of the buildings from the ground and so to protect them from the floods. They are generally carefully built of unburnt bricks laid in mud mortar. The use of unburnt bricks in their construction was perhaps deliberate because even if the lower part of such a platform gets immersed in water for some time, the water would

not rise through the unburnt bricks by capillary action, while if burnt bricks are used there is likelihood of water seeping up. In the later phases of the city life, such specific platforms were not provided for construction and in their place the previously fallen buildings with proper filling served almost the same purpose.

FOUNDATIONS

The larger buildings of the flourishing period of Mohenjo-daro have very deep foundations. These foundations are usually wider than the building walls above them so that a well-defined footing is left around the inside of each room. These foundations are filled with crude burnt brick-bats. Smaller buildings had shallow foundations filled with burnt clay nodules only. Some of the very small structures of the poor classes, particularly in the declining phases of the city, had no foundations at all.

BRICKS

All the bricks taken out from anywhere in the Harappān sites are very well made indeed. They have no straw or other binding material in them. They seem to have been made in open moulds and stıuck along the top with a piece of wood. Bases of these bricks are rough and sometimes have potsherds and bits of charcoal adhering on to them, indicating that they were made and dried in the open. They are all well-baked and burnt and range in colour from straw to bright red. Material of which these bricks are made is the ordinary alluvial soil, the kind of which is still found at Mohenjo-daro and Harappā. Usual size of the bricks is $11 \times 5.5 \times 2.5$ inches. Dimensions of the largest brick found are $20.25 \times 10.5 \times 3.5$ inches and this was found covering a drain. In the construction of the bathrooms, bricks which had been appropriately cut with a saw were used, as they provided better alignment of their ends and thus helped to make the floor seepage proof.

MORTAR

Generally mud mortar was used in between the bricks. In some of the important-looking buildings, gypsum cement of a light gray colour was used on the outside to prevent the mud mortar from crumbling down. In a very well constructed drain of the Intermediate period, the mortar which was used contains a high percentage of lime instead of gypsum.

Bitumen was found to have been used only at one place in Mohenjo-daro. This was in the construction of the great bath, to make it completely water-tight. Bitumen was, it appears, not available locally at Mohenjo-daro but was imported from outside.

FLOORS

At Mohenjo-daro, in most of the better-class buildings, floors are made of burnt bricks laid either flat or on edge. The latter method was employed in bath-rooms or wherever else there was likelihood of a lot of wear and tear of the floor.

In most of the buildings at Harappā and in some at Mohenjo-daro, the floors are made of sun-dried bricks or are just paved with mud. But in the bath-rooms everywhere only the burnt-brick floors are provided.

THRESHOLDS

Thresholds of many of the houses are considerably higher than the street level. In some cases a short flight of steps and a small platform leads into the house. This was to check the flood water entering into the houses from the streets.

DOORS AND WINDOWS

While at Harappā many of the buildings are completely destroyed, in Mohenjo-daro ground-floor rooms still exist. These rooms received light and air through the doorways. The usual

width of a doorway is 3 feet 4 inches. A bolt hole (door socket) has also been found at one place. It is made inside a burnt brick. The doors, perhaps, moved by means of rounded wooden projections attached to one of its sides at the top as well as at the bottom. These projections moved* in the sockets provided for them in the brick or the mud floors and in the wooden lintels at the top.

Windows in the outer walls of the buildings are rare. Sometimes mere slits have been found. May be higher up in the rooms there were some air-vents or windows of which there is no evidence now because of general destruction. It seems that both doorways and windows were generally spanned over by flat wooden lintels.

STAIRWAYS

Stairways in the houses lead to the roof or the upper storey. The steps of these are made of bricks and are narrow and steep.

CEILING

There is evidence to show that ceilings and roofs of the houses were flat. In some of the better-preserved walls, beam-holes have been found which indicate the use of long wooden beams. These beam-holes are generally 9 inches square. Rectangular ones, 9×13 inches have also been found, in which case the longer measurement is vertical. These beam-holes have been found at a distance varying from 5 feet 4 inches to 10 feet 6 inches from the floor. On the wooden beams, wooden planks must have been placed as the spaces between the beams are generally too wide. Reed-matting was then laid over the planks and covered over with a thick layer of mud. This makes a roof water-tight. This method is still used in the villages in India.

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*This is one of the examples of the use of partial rotatory motion by the Harappāns.

FIRE-PLACES

These are only slightly raised platforms placed against one of the walls. Wood was used as fuel in them.

CORBELLED ARCH

Only the corbelled and not the true arches have been found in the Harappān cities. They were made frequently over the top of the doorways. They were also made to cover large water drainage channels in the city.

A TYPICAL HOUSE

A nicely preserved house in Mohenjo-daro in an area (HR) shows the inside plan as follows: Out of a lane 5 feet wide a doorway opens into a small court with a tiny room on the side facing the doorway. A short passage which has a small room with a well to the south, leads into the main courtyard 33 feet square. The room with the well communicates through a small corbelled opening with a bathroom whose floor is made of precisely-laid bricks. The room next to it has in its floor an earthenware pipe encased in brick-work which goes from the courtyard to a street-drain. Another earthen-ware pipe built vertically into one of the walls of a series of small rooms on the eastern side of the courtyard, carries drainage from the roof or the upper storey. This roof or upper storey is reached by a brick stair-case located in a compartment on the north side of the court.

From the above description of the buildings, it is not difficult to understand as to how much preliminary experimentation with various building materials and various plans of the buildings for comfort and hygiene, must have been put in by the Harappāns.

4

Public Health and Drainage System

A remarkable feature of the city of Mohenjo-daro and other sites of the Harappā civilization is the very elaborate drainage system that existed even in the poorest quarters of the city. There are unmistakable signs everywhere that the question of conservancy was one of prime concern to the civic authorities.

Drainage system can be described as that of (1) the houses and buildings and of (2) the city and its streets.

HOUSE DRAINAGE

There are not many drains inside the houses. This is because the kitchen and the bath-rooms are, as a rule, placed next to the street wall, so that the waste water did not have far to flow. The drains that have been found are simple in construction and closely resemble the street drains except that they are more carefully constructed. Wherever possible they are laid immediately under the paved floors so that they could be readily uncovered, and cleaned. These drains are constructed with bricks or the drain pipes.

The drain pipes are made of ordinary clay tempered with sand and lime and moulded as pottery on the wheel. These pipes are either simply tapered or have spigotted ends with or without projecting flanges. End of the one fits into the beginning of the next. Individual pipes average 22.3 inches in length with an outside diameter of 6.3 inches at one end and 8.1 inches at the other. Their thickness is 0.4 inch. Inside of the pipe is better finished

than the outside. This shows that the potter appreciated the importance of a smooth interior and he also knew that a roughly finished exterior was an advantage in that it was held firmly in its place. These pipes are laid horizontally as well as vertically. For vertical use they are embedded in the brick work. Gypsum or mud is sometimes used around the joints to prevent the leakage of water.

Gutters were also used for carrying off drainage water. They are either made of bricks by cutting channels through them or are made of pottery. Pottery gutters are much longer than the brick-ones.

Bath-rooms: These are present in almost all the houses. In private houses they are generally located on the ground floor but are also found on the upper. They are connected with the street drainage system. Foors of these both-rooms are rubbed smooth due to constant wear and tear.

With the exception of a few, no latrines have been satisfactorily identified as yet.

Chutes: One or two apertures in the walls let the out-flow from the ground-floor rooms into the street drains. These apertures vary in length from 14.5 inches to 56 inches. They are $3\frac{1}{2}$ to 13 inches wide and are in line with the inner drains.

From the upper floors and roofs the out-flow comes through sloping or vertical chutes made in the thickness of the walls. In general, these chutes are square or rectangular in section with the outlet set at angles varying from 30°— 45°. This is to prevent splashing. In some cases there is actual stepping down of the decline. Some of the chutes project over slightly from the walls. The base of the chute is frequently situated higher up above the jar or the drain into which the water was discharged. These chutes carried off water from the bath-rooms and other waste water from the house-hold work also.

Drainage Jars: Occasionally the chutes do not open into the street drain but do so into a large pottery jar placed beneath the chute. Some of these jars have rough holes in their bottoms and the water seeped through them into the ground. Many of these

jars were fixed in the ground by bricks and thus made immovable.

Sediment Pits: Water from better-class houses, instead of discharging into the jars, did so into well-built pits. These sediment pits have brick floors. Water entered and left them at levels higher than that of their base. This way the solid matter settled down in the pits and did not choke the street drains. Some of these pits are very small and indeed would have needed repeated cleaning. Their average dimensions are, length 23 inches, width 15 inches and depth 11—18 inches.

CITY AND STREET DRAINAGE

Every street and lane at Mohenjo-daro has one or two drains. These are, as a rule, set 18 to 24 inches below the surface of the street but some of them are quite superficial. They are made of burnt bricks joined together with mortar. Their walls and floors are scrupulously laid. In the smaller and less important drains, the base is made of bricks laid flat, while in the better and wide channels the base is thicker and is formed by laying the bricks on edge.

When smaller drains had to enter the wider ones, they did so after taking a gradual curve so as to facilitate free movement of water. These curves are generally made of ordinary bricks but wedge-shaped bricks are also used sometimes.

Soak Pits: Unpaved pits measuring approximately 5×4×6 feet have been found along the course of the street drains, particularly at the points where the smaller drains entered the larger ones. They have a few steps inside them. Their purpose seems to be to let the excessive water be soaked into the ground.

Methods of Covering Drains: Uncovered drains, besides being ugly to look at, are also thoroughly unhygienic. Obviously, the Harappāns were aware of this second aspect also, otherwise they would not have cared to cover all their drains.

Drains are covered over either by bricks or by stones in such a way that the covers can be easily lifted to facilitate removal of any obstruction in the drains. Different methods have been used to

Covered Drain, Mohenjo-daro

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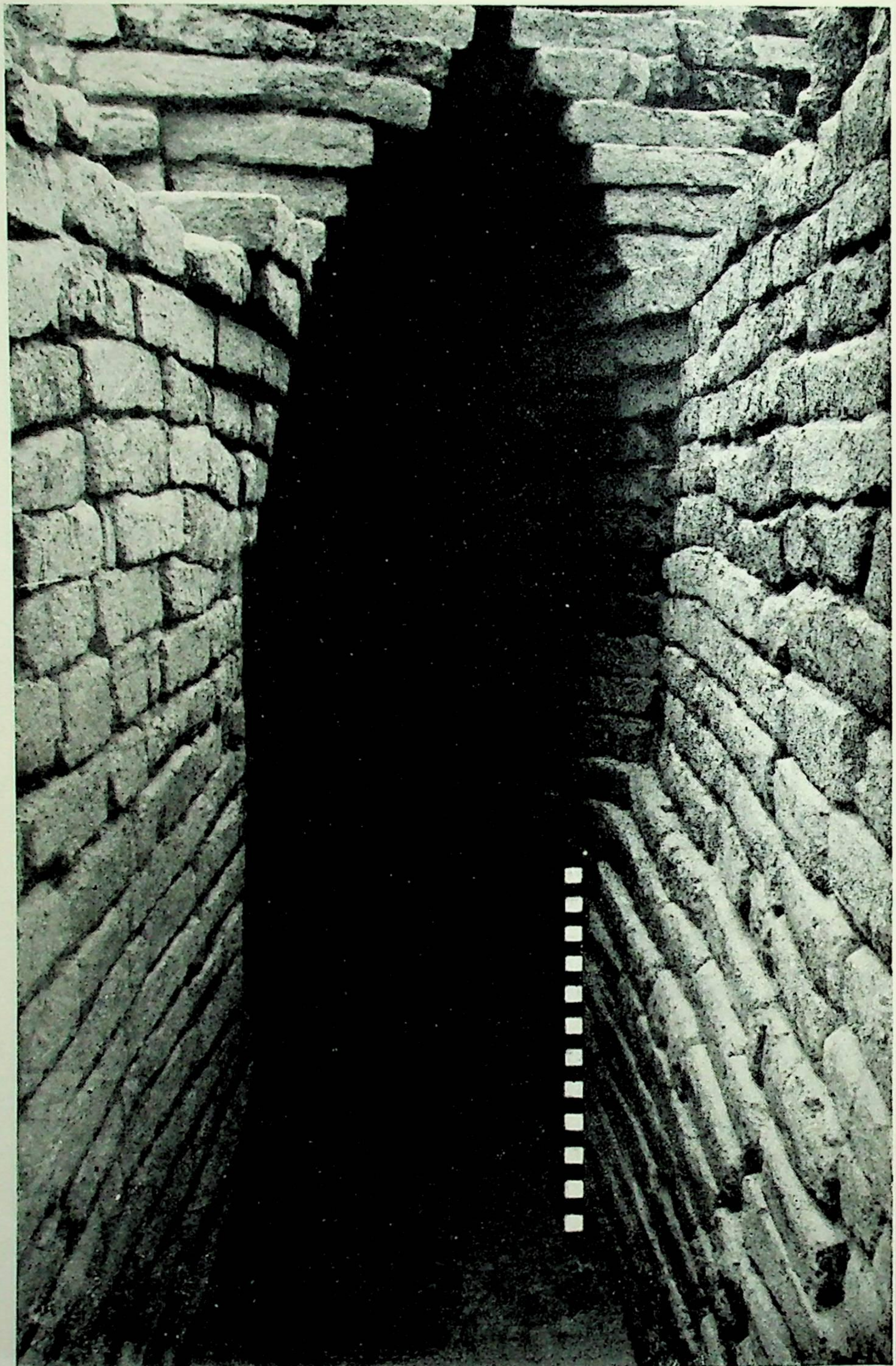

Corbelled Arch, Mohenjo-daro

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cover different drains. The commonest method is to bridge the narrow channel by means of a brick and to further lay two or three more bricks onto it to prevent caving-in, where there was heavy traffic over it. Wider channels were covered over generally by big slabs of stones or larger bricks. Some of the very wide water channels were covered over by corbelled arches made of bricks.

5
Water Supply

Discovery of a large number of wells in the city of Mohenjo-daro, inspite of the fact that it was situated along the river, shows that water for domestic consumption was derived mainly from them. At Mohenjo-daro, most buildings had wells of their own. Wells for public use were sometimes provided in private houses, enterance to the well-chamber being directly from the street. A public well was frequently placed in a cul-de-sac between the two houses.

WELLS

Wells are generally circular, 3 to 4 feet in diameter. Some of them are oval also. Bricks used for their construction are nicely moulded and burnt and are invariably wedge-shaped. There are pavements of bricks laid around the wells. These pavements generally slope towards a drain at one corner so that it takes away the spilt water. Mud mortar is the only substance used to lay the bricks. Top of the well is generally higher than the floor of the room or the compound in which it is situated. This prevented re-entry of the spilt and dirty water into the well.

There are no friction marks along the sides of the wells that would normally have occurred if ropes had been used directly to draw out the water. One can assume that on these wells windlasses made of wood were used which have perished with the passing of time. Another possibility is that the water from such wells was drawn out by the person standing over the wells with the legs fixed diametrically opposite. These wells are conveniently narrow for such a posture.

Hygienically Built Well, Mohenjo-daro

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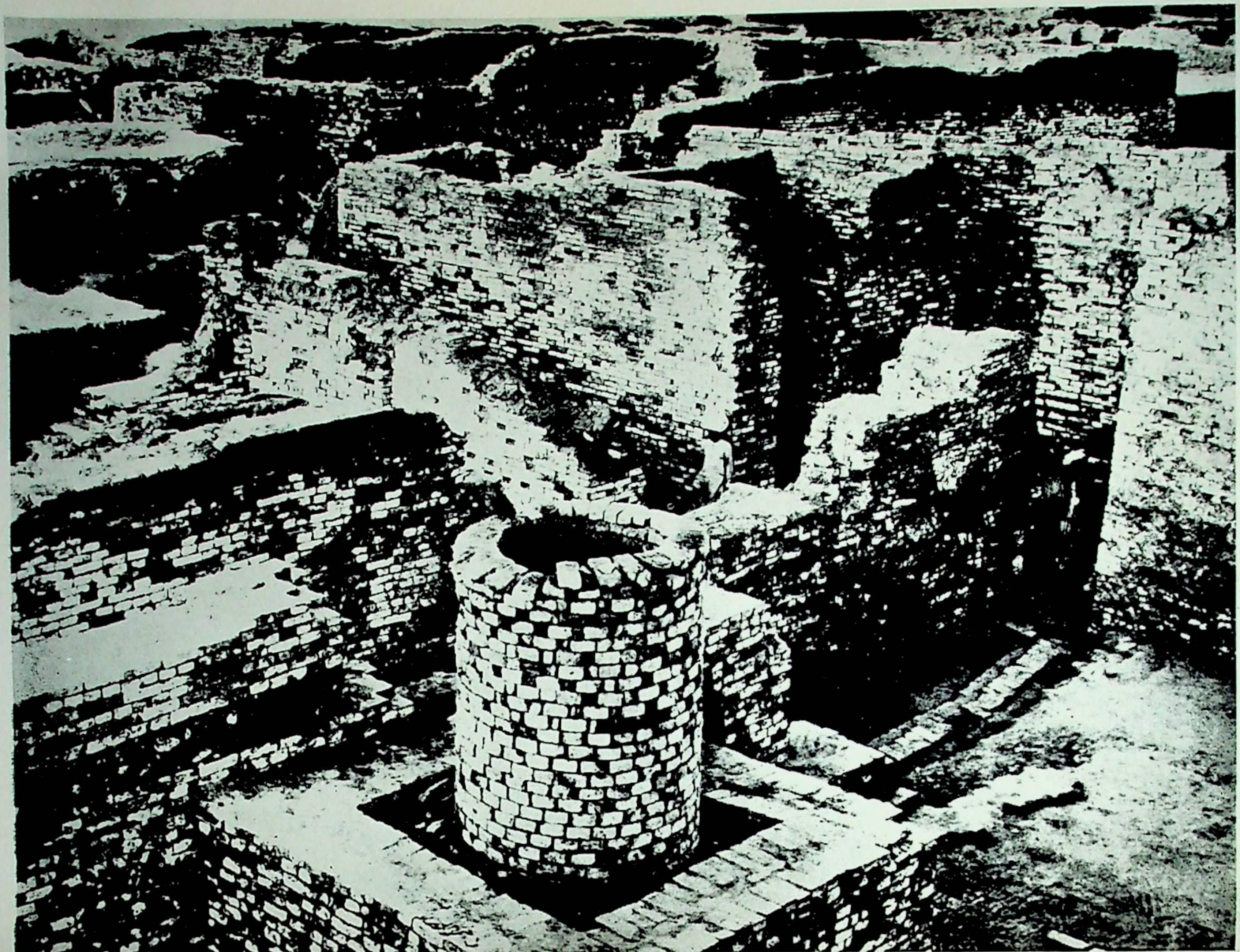

Well with Raised Steening, Mohenjo-daro

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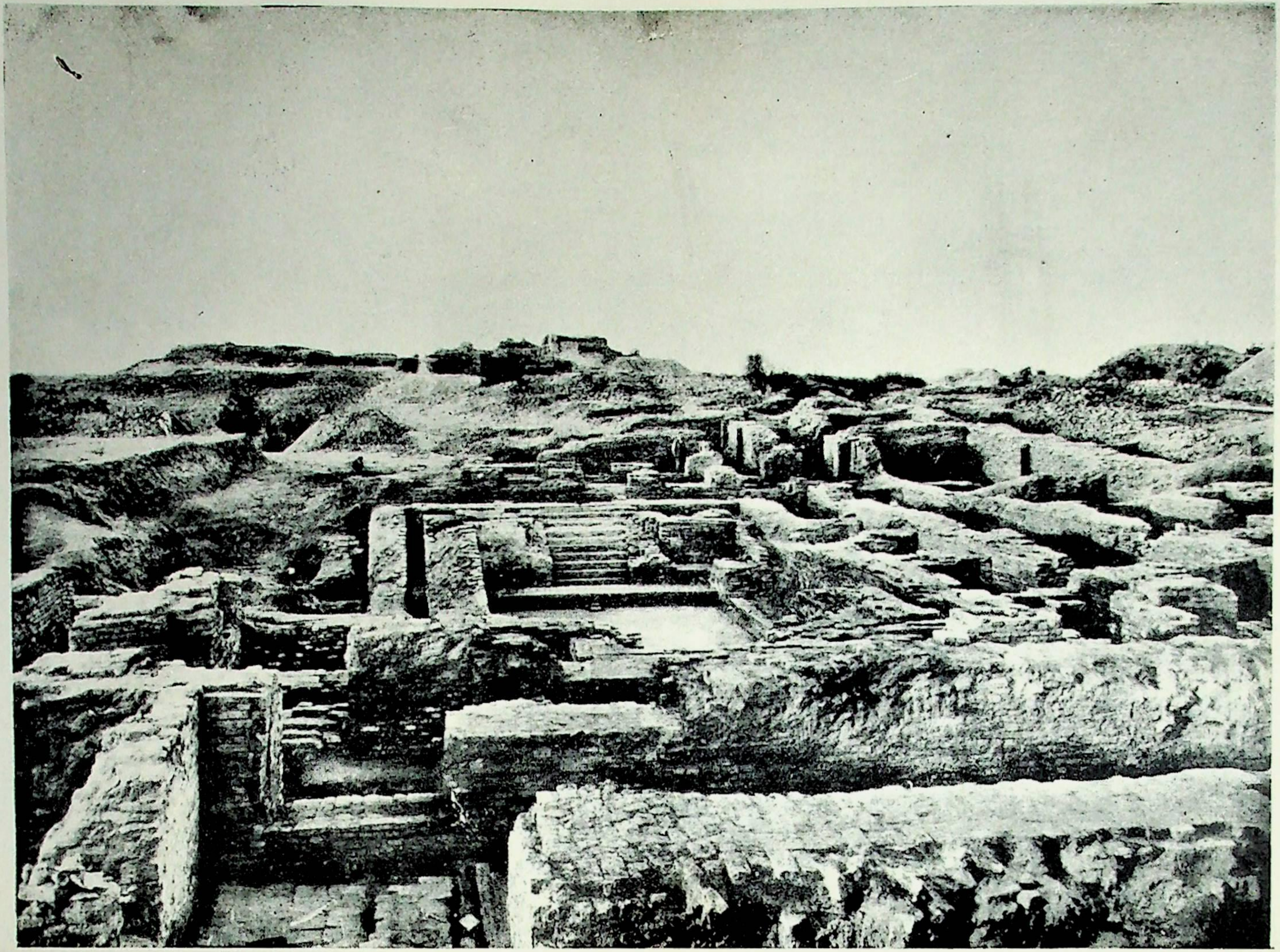

Great Bath, Mohenjo-daro

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From the construction of these wells we can clearly see that the Harappāns understood and provided almost all the features that an hygienically constructed well ought to have.

The steenings of many of the wells seem to have been raised from time to time, as the level of the surrounding buildings was raised to protect them from the floods. Digging of the new wells in this situation was much more difficult because it needed a lot more digging. Sometimes instead of raising the steening, a stair-case was built to go down into the well-chamber.

At Harappā, on the other hand, it looks, people who lived near the river obtained their water for domestic use from the river and perhaps that is why there are so few wells over there.

GREAT BATH OR TANK

Situated within the citadel of Mohenjo-daro, the most imposing of all the structures is the tank along with its associated buildings. Plan of this whole complex is somewhat as follows:

In the centre is an open quadrangle which contains the tank. On the four sides of this quadrangle, there are the verandahs and at the back of three of these verandahs there are the rooms and galleries. Behind the southern verandah is a long gallery with a small chamber in each corner. Behind the eastern verandah is a row of small chambers in one of which is situated a well, and behind the northern verandah is a group of several halls and other large rooms. Maybe that on top of these buildings there was an upper storey also. This is indicated by the fact that a stair-case goes up from one of the rooms and also there are drains descending from above.

Tank: Dimensions of the tank are: length 39 feet 4 inches (west) and 39 feet 3 inches (east), width 22 feet 11 inches (south) and 23 feet 4½ inches (north). It is sunk 8 feet below the paving of the courtyard. It is constructed with specially made bricks of the size varying from $10.15 \times 5.1 \times 2.2$ inches to $11 \times 5.15 \times 2.25$ inches. These bricks have plane faces and sharp edges.

Water-Proofing: In the construction of this tank every conceiv-

able precaution seems to have been taken to prevent seepage of water and sagging down of the foundations. The bricks are carefully laid on edge in 3 to 4 inches thick mortar which contains a lot of gypsum, sand and lime. At the back of this is a one-inch thick damp-proof course of bitumen. This is kept in place and prevented from crumbling down by another thin wall of burnt bricks behind it. At a little distance from this is another burnt brick wall all around; the intervening space being thoroughly filled in by means of crude bricks or brick pieces. Total thickness of the walls of the tank is thus uniformly 4 feet 5½ inches.

As an added precaution the space between the encompassing brick-wall and the verandah foundations is interspersed with short cross walls to further counteract any outward pressure. It is certain that a better method of constructing a water-tight tank could not have been devised. This tank even now is astonishingly well-preserved.

There is a raised platform at each end of the bath, extending its entire width. It is 3 feet 3½ inches wide and is 1 foot and 4 inches above the floor of the tank. Leading down to each is a nicely-constructed flight of steps about 8 feet wide.

The floor of the tank is approached from the north and the south by brick steps initially fixed with wooden treads set in bitumen or asphalt.

The tank was perhaps filled with water obtained from the well. The waste water was carried away through a large channel situated near the south-east corner. Corbelled roof of this channel is 6 feet 6 inches high.

6
Transport

In the earliest Stone Ages, when man hunted and gathered food and had no settled place to live, perhaps, the idea of having a conveyance never occurred to him. In the Neolithic times, heralded by agriculture, it became necessary for him to transport the harvest. Domesticated cattle or the donkey performed this work fairly well. Later, however, with the development of urban societies and trade, the things to be bartered or traded, had to be carried to the city markets at long distances. So the need was felt of a land conveyance.

The idea of having a wheeled transport was perhaps derived from the pottery wheel which being heavy had to be taken in and out of the hut or from one place to another by rolling it over its circumference. Two such wheels connected by an axle could serve as wheels of a conveyance whose superstructure, in convenient shapes, could carry any load. Such a wheeled land transport could be easily pulled by one or two cattle or donkeys.

Wheeled transport necessarily required smooth roads and bridges over them wherever there was an intervening rivulet. Roads with prepared surfaces were invented later on and they came into being only in some of the big cities.

Rivers and seas also served as a medium of transport for man and his goods. Small dug out canoes, bundles of reeds, bamboo rafts or just anything that would safely float and carry man and his load on top of it, served this purpose in the beginning. Small and large boats came only later.

A by-product of the availability and development of land and river or sea transport was the easy exchange of ideas and inventions between the far off places and peoples. In our own times this has brought even distant peoples together.

WHEELED VEHICLES

No actual specimen of a full-sized wheel or wheeled vehicle has been found at any of the Harappān cities or sites. However, plenty of miniature wheeled carts made of pottery and used as toys by the children, and also one or two miniature metallic carts were found. They give some idea of the type of wheeled vehicles used by the Harappāns.

Cart Frames: Frames of the toy carts discovered at Chauno-daro are in several shapes and patterns. The commonest variety has four vertically pierced holes on each side meant probably to fix stakes of wood. The four holes at the middle take longer stakes projecting from the underside of the frame in pairs, between which easily removable axle of the wheels is held. There are also horizontal holes for the shaft through one end of the frame and the middle cross-piece.

With the floor made of matting or of a rope-net, these open frames could carry agricultural products easily.

Second type of cart frame is box-like in shape with a partition across the middle.

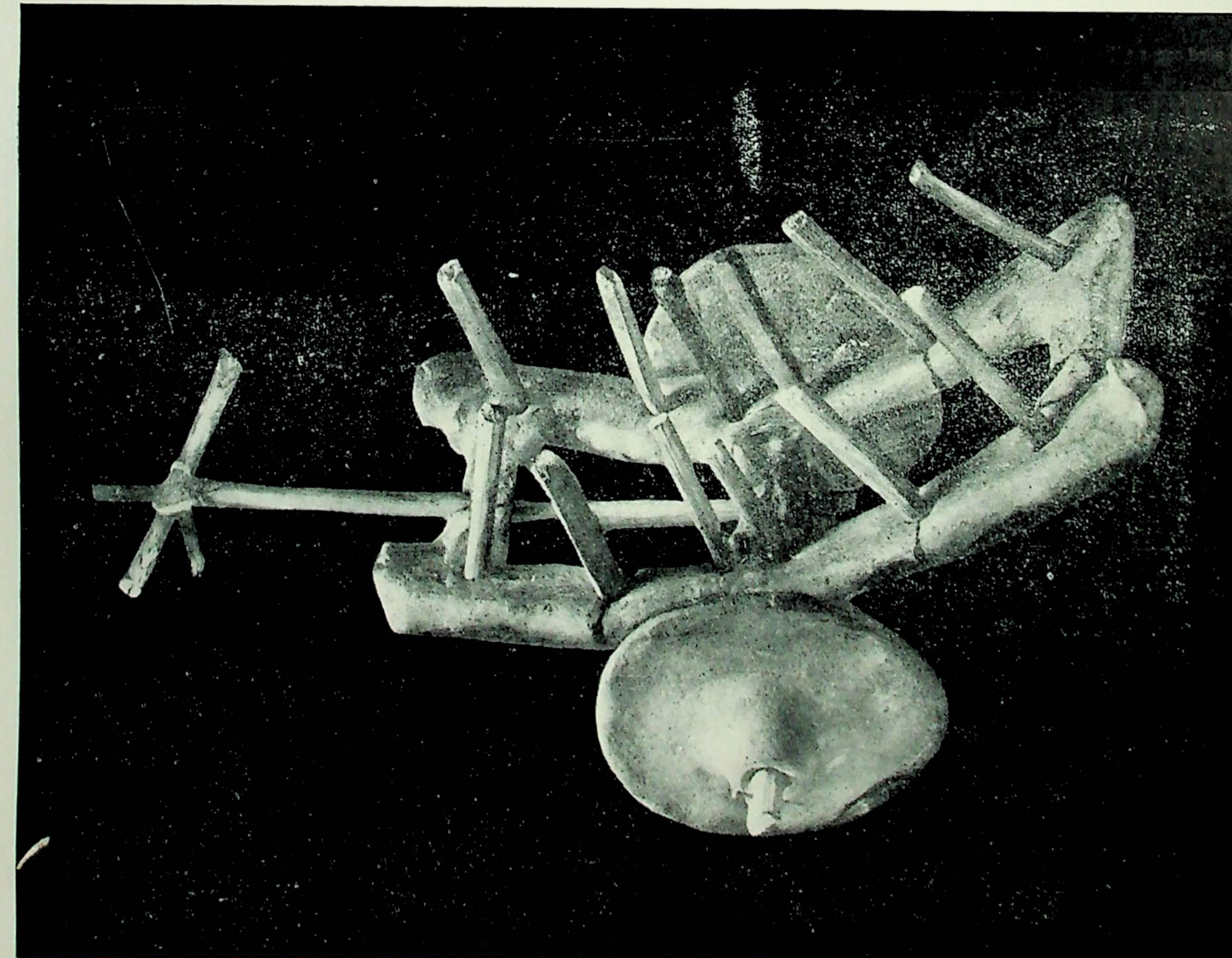
The third type is rather modern looking one, in which a hole for the shaft pierces the frame longitudinally and in some of the specimens there are holes for uprights along both the longer sides.

Some of the cart frames at Mohenjo-daro and Harappā instead of being straight have a V-shaped projection both in front and the back. There are others approximately square with concave bodies, low side-walls and a vertical flattened projection at each corner. There is another one also shaped like a canoe.

It is interesting to note that both at Mohenjo-daro and at Harappā the toy cart frames are more or less similar.

All these cart frames have one characteristic in common. It is easy to dismantle the vehicles by simply lifting the frames off the axles. Such facility in dismantling must indeed have been an important consideration in the construction of these vehicles at a time when effective roads and bridges were not very common.

Wheels: Pottery wheels of the toy-carts are of three types.



Complete Cart, Kalibangan

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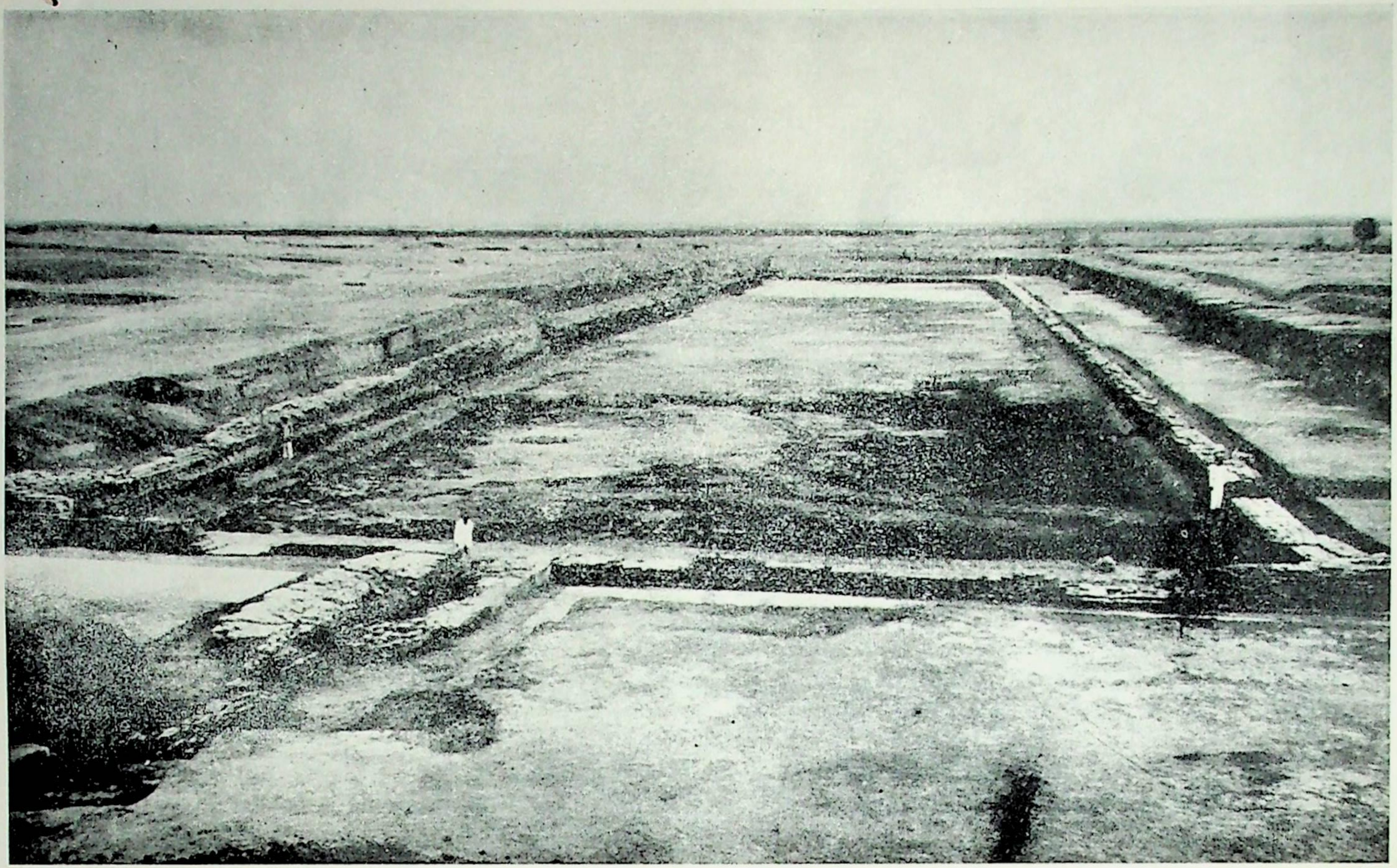

Dock-Yard, Lothal

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The commonest one has a prominent hub on one side. In the second variety, both sides of the wheel are markedly convex. In the third, the wheel is plain on both sides.

Painted pottery models indicate that the actual wheels were perhaps, made of three solid pieces of wood, the projecting hub being in one of the middle pieces of the wheel.

The two-wheeled carts and the four-wheeled chariots of the Harappāns were probably drawn by two animals, yoked to a pole which projected from the frame horizontally, as is indicated by the holes in the toys.

Metallic Miniature Carts: Two miniature carts made of bronze discovered at Chauno-daro also give an idea of the wheeled vehicles of that time. One of them is 2.93 inches long, 1.2 inches wide and 1.75 inches high. A man is seated in front on one of the cross members of the frame with a stick in his right hand. The sides of the frame of the cart consist of an upper and a lower bar connected by uprights at each end. The two wheels, each 0.93 inch in diameter and 0.09 inch thick, are soled. The shaft runs under the cross-bars instead of through them, as was perhaps the case in actual carts. Unfortunately the front part of this metallic cart is broken and so is unavailable for study.

The second wheeled toy-vehicle made of bronze, is 2.4 inches high, 1.71 inches long and 1.1 inches wide. Its under frame has four cross bars. Each side has crossed struts between supports at each end for a pent-roof. A transverse cross bar at each end of the cart seems to have kept the canopy supports upright.

NAVIGATION

Cities and towns of the Harappā civilization were situated along the rivers. One of the attractions of this situation for the Harappāns must have been the transport facilities that such a location provides.

Dock at Lothal: Discovery at Lothal of a huge dock for berthing boats and for handling cargo is an indication of the navigational skill of the Harappāns.

Recent discovery of five anchor stones in the basin, the vertical walls of the structure with no provision such as steps to reach the bottom of water and the extraordinary salinity of the silt of the area, prove beyond doubt that this was a dock area. River Sabarmati which now flows at a distance of about two miles, perhaps then flowed nearer it and at high tide the water was carried inwards through a brick-built canal to facilitate navigation.

This dock is situated to the east of the town. It is roughly trapezoidal in plan and measures from north to south 710 feet and from east to west 120 feet. Built with baked bricks, its present height is 14 feet. There is a large 23 feet wide opening in the wall on the eastern side which is possibly the inlet channel. On the south is a smaller opening, the spill-channel, which may have served the purpose of regulating the out-flow of water by the insertion of a wooden door in the grooves which are present at its mouth. The techniques used for water-locking and construction of the spill-way for desilting, construction of buttress-walls on either side of the inlet in the eastern embankment, and the solid platforms on three sides to guard against the thrust of tidal waves indicate high technical skill of the designers of this dock.

There is a mud-brick platform 800 × 42 feet in area adjoining the western embankment. This was perhaps used for handling cargo. The dock-workers themselves lived in the structures built on the clay platforms adjoining the northern embankment.

Boat on Seal: One of the seals found at Mohenjo-daro has figure of a boat etched in it. This possibly represents the type of boats used by the Harappāns. This boat has a sharply upturned bow and stern. It is lashed together at both bow and stern indicating perhaps that it was made of reeds. Fastened at each end of it, is a standard bearing an emblem. At one end of the boat a steers-man is seated at the rudder.

It may be that the Harappāns provided sails to their boats to steer them in different directions. The sails increase the range of shipping and the Harappāns are known to have settled at and traded with far-off places along the western coast of the Indian subcontinent.

Boat Design on a Seal

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7
Agriculture

Great cities of the Harappā civilization could not have come into being unless there was a lot of agricultural surplus to feed those who specialized in other crafts and trades. Location of cities along the banks of the rivers greatly facilitated irrigation and transport of the agricultural and other products.

Whether Harappāns used a hoe or a plough for making the soil fit for agriculture is not known, as no such objects have yet been clearly recognised. It is possible that some of the flint implements which have been recovered in plenty served as ploughshares. No irrigation channels have either been recognized around the city sites.

Some roughly made pottery jars with deep grooves around their middle with the characteristic shape of the base and the rim, have been recovered in plenty at Mohenjo-daro. They might have been used, after fixing them in the fashion of a Persian wheel, to draw water from the wells and to use that for irrigation.

STORAGE OF FOOD-GRAINS

A large surplus of food-grains collected at the time of harvesting needed to be stored properly and protected from inclement weather and pests, so that it could be made available and utilized at the time of need. In the Harappān houses—as even now at some places in the villages of India—grains were stored in large pottery jars which were fixed in the ground so that their rims were at the level of the surrounding earth. This rim was covered over with a pottery lid. Some of these lids fit so snugly that there is no possibility of even an insect crawling inside the jars.

This arrangement suited well for domestic needs, but where the food-grains had to be collected in huge quantities for large groups of populations such as in the cities, then there was need for more elaborate structures and buildings. The Harappāns, we find, were well-equipped for such needs also.

GRANARIES

Granary buildings have been discovered, one at each of the sites of Harappā, Mohenjo-daro and Lothal.

At Harappā, the granary is the largest of the buildings that have been excavated. Total area covered by it is 168 feet from north to south and 135 feet from east to west. It consists of two exactly similar blocks, opposite to each other, with a 23 feet wide passage between them. All this is built upon a platform of mud 4 feet high.

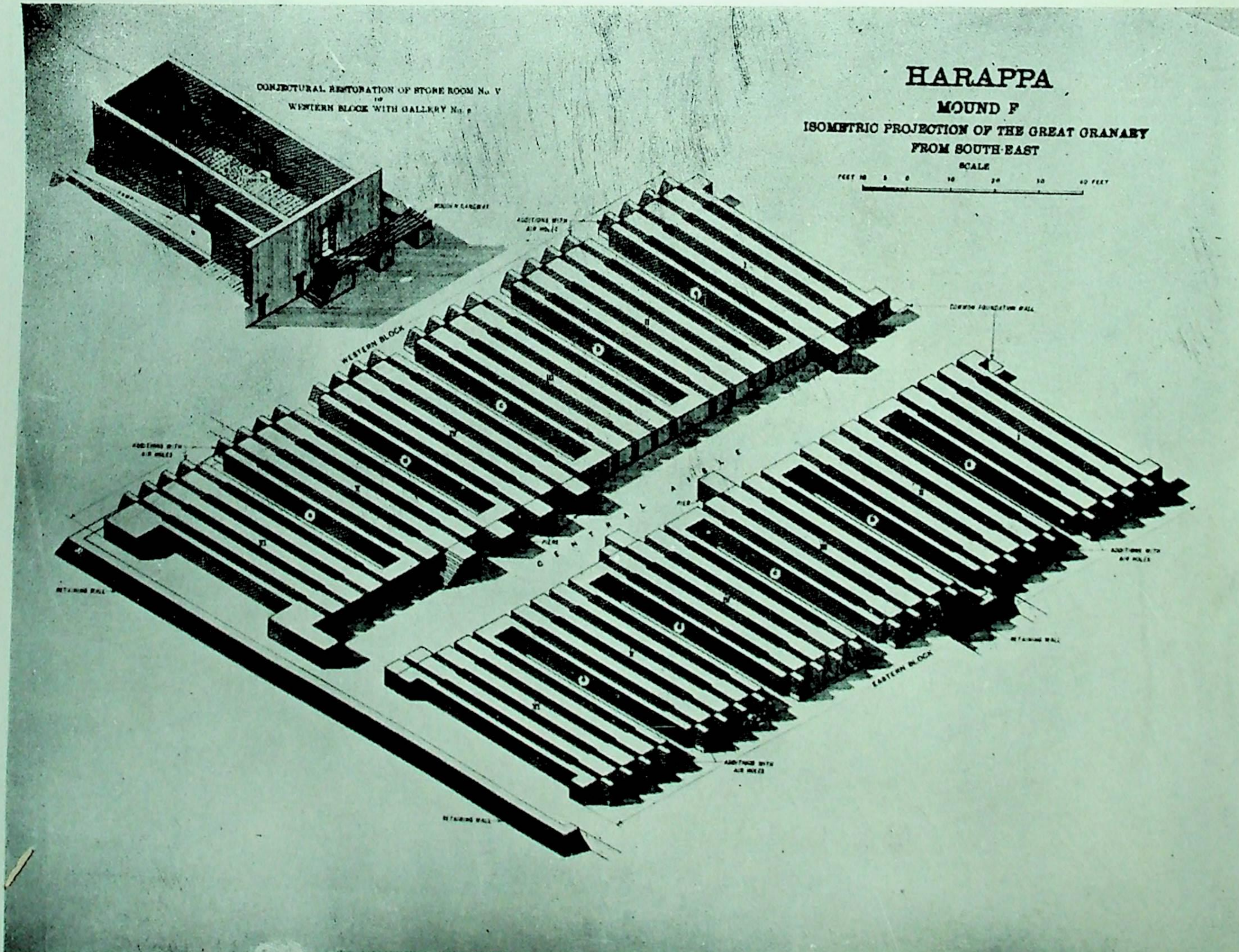
Each of the two blocks has six chambers or halls in it, alternating with five corridors in between, which open only on the outside. Each of these chambers is further partitioned into four narrow divisions by means of three equi-distant full-length walls. These chambers are entered from the central passage by short flight of brick steps.

The floors of the individual chambers are carried clear off the ground on sleeper-walls, three in each chamber, whose purpose seems to be to provide space for the free movement of air so as to prevent the grain from rotting. As the level of the other outside buildings was raised to prevent flooding, these air-providing channels beneath the floors became liable to be chocked, so that small projecting air-vents on the outside were provided to conduct the air.

Combined floor-space of the 13 granary chambers is about 12000 feet.

Approach to the granary seems to have been from the river side, which suggests the use of water transport for incoming or outgoing supplies of grain.

The granary at Mohenjo-daro is situated at the periphery of



Diagramatic Scheme of Granery at Harappā

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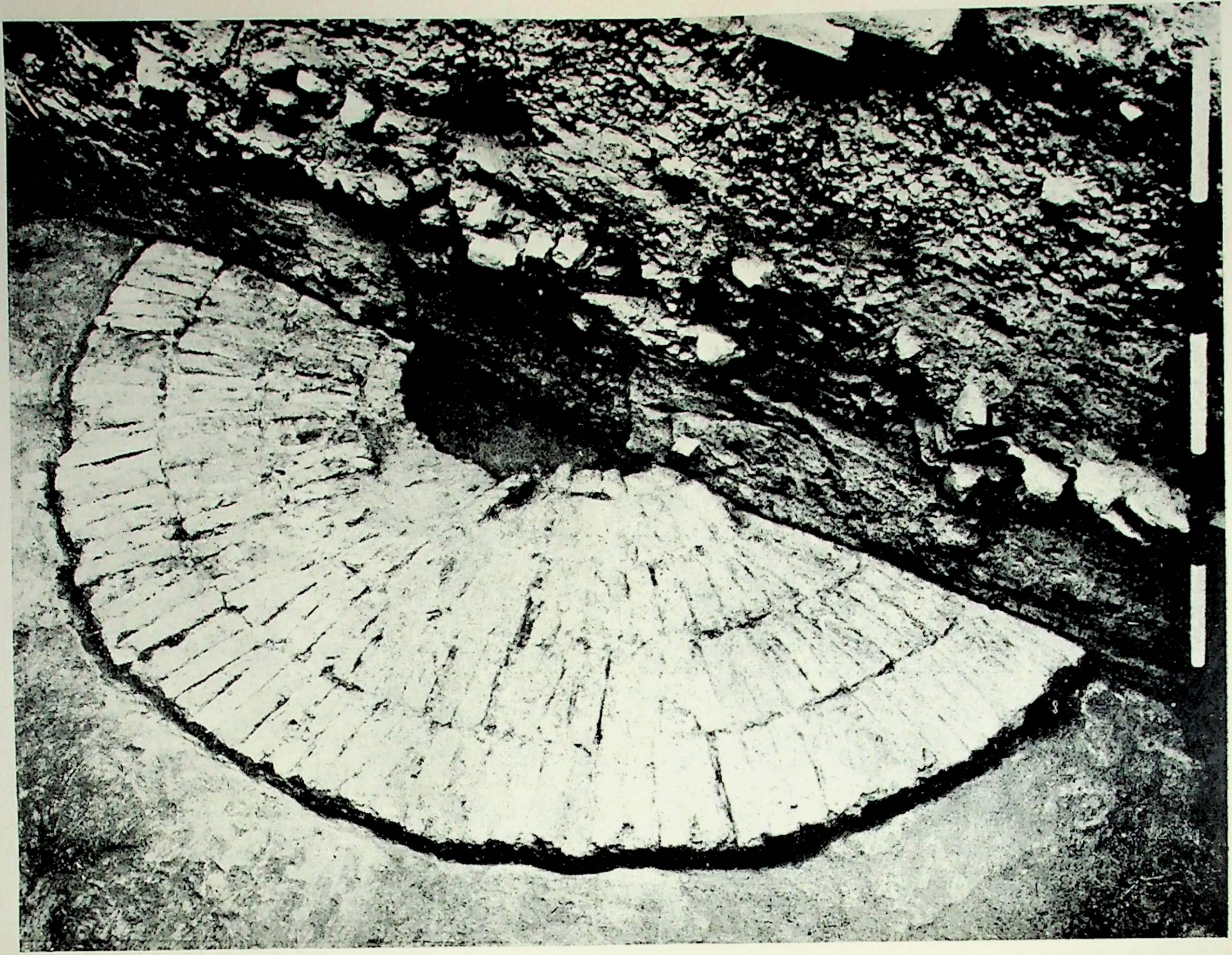

Pounding Platform

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the citadel mound. It is 150×75 feet in area and consists of 27 blocks. There is evidence of other later additions to this main building also. The criss-cross layout of the passages between the blocks ensured circulation of air to protect grain from rotting. External walls of the granary are battered or sloped and this gives the whole structure an appearance of a fort. Combined floor space of this granary is approximately the same as that of the granary at Mohenjo-daro.

At Lothal, overlooking the dock, is the structure considered to be a granary. It stands on a 12 feet high mud-brick platform measuring 165×145 feet in area. It consists of 12 cubical blocks on which might have rested the superstructure of the granary. There are intersecting passages between the various blocks, each of which seems to have been 12 feet square and 3½ feet high. It seems that originally this structure served as a warehouse in which sealed packages of goods, received from foreign countries, were stacked.

POUNDING PLATFORMS

Near the granary at Harappā, there are rows of platforms which seem to have been used for pounding grains. They are made of bricks and each one measures 10-11 feet in diameter. There is a central hole in each which was probably meant to hold the wooden mortar. Fragments of husk, burnt wheat and husked barley were found in the central holes of some of these platforms.

QUERNS

A large number of stone querns have been found both at Mohenjo-daro and at Harappā which look to have been used for grinding cereals. All these are saddle querns and no specimen of any revolving quern has been found. Of these saddle querns there are two main types: those on which an other stone was pushed or rolled to and fro, and the others in which a second stone was used as a pounder. Majority of them are made of sandstone or quart-

zite. Better ones are made of basalt and they show evidence of a lot of usage. In some of them, constant grinding has led to a depression as deep as 5 inches. Average size of these querns is 21×9 inches. Bases of these querns are usually convex which indicates that they were fixed in the earth at one place so as to prevent them from rocking while in use.

The mullers used for these querns are generally cylindrical stones averaging 11×4 inches. These have been bruised only at the ends, which indicates the part used. The smaller mullers are four-sided.

AGRICULTURAL PRODUCTS

Grains of wheat and barley, husks of rice, pieces of cotton textiles, date-seeds, peas, sesame and melon-seeds have been found at various sites of the Harappā civilization.

Wheat: Wheat grains that have been found at Mohenjo-daro show wide variation in their size and shape. They seem to belong to the varieties called Triticum compactum and Triticum sphaerococcum, both of which are still cultivated. It is surprising to know that recently it has been found out that these dwarf varieties of the wheat plant yield much more grains than the modern ones and hence efforts are being made to grow them on large scale.

At Harappā also, carbonized wheat grains of the variety Triticum compactum were found.

Barley: Barley grains found at Mohenjo-daro have been identified as Hordeum vulgare and the ones found at Harappā belong to a variety called Hordeum vulgare var. hexatichon.

Rice: Rice husks were found in the mud-plaster at Lothal granary.

Cotton: Minute pieces of cotton-cloth finely woven, were discovered at Mohenjo-daro, providing evidence of the use and cultivation of cotton in the Indus valley. This was at a time when cotton was unknown in any other part of the world.

Date: A few carbonized date seeds have been found at Mohenjo-daro indicating that date was known and eaten.

Peas: Charred peas of the variety Pisum arvensu were found at Harappā.

Sesame: A lump of charred sesame was found at Harappā.

Melon Seeds: These were found at Harappā in an earthenware jar.

Charred remains of reed and bamboo were also found.

Timber[32]*:* Remains of four different varieties of commercial timber have been recognized at Harappā. These are (1) Dalbergia latifolia (rosewood), (2) Cedrus sp ? Deodara (deodar), (3) Zyphus sp (ber), (4) Ulmus sp (elm).

It is interesting to know that similar varieties of wood were also found at Sumer and Mesopotamia, where some of them were used for making tops of the coffins.

Besides the actual recovery of the above agricultural products, objects or figures of lemon leaf, pomegranate and coconut fruit were found sketched on jewellery and pottery, indicating at least, the familiarity of the people of the Indus valley with them.

8

Mat-Making and Textiles

Making of mats and baskets must have been common enough in different Stone Ages. In Neolithic and later periods, easy availability of basic and more useful materials through agriculture, as well as the augumented needs for collecting cereals and grains provided an impetus to this industry.

Basketry, mat- and rope-making are generally distinguished from weaving, but it is difficult to draw a clear-cut line between them. Textile is the general name given to the products of the weaver ; derivation of the word textile being from Latin 'texere', meaning to weave. Baskets and mats are made by hand by interlacing two or more strands in different ways, in a manner not dissimilar to that of making textiles.

Basketry, mat- and rope-making must have been extensively done by the Harappāns but only meagre evidence of this is available now, as for example the impression of the reed mats on the mud that fell when the roofs caved in or on some of the bricks which while drying were placed on the reed mats.

We all know that weaving and basketry involves use of arithmetic and weaving-in of patterns in them involves some knowledge of geometry also. One can guess that the Harappāns were familiar with these aspects.

SPINNING

To make textiles out of the raw cotton, the initial step is that of spinning. This is the process of drawing out and twisting of the fibres so that they arrange themselves in more or less parallel order. The irregularities of the fibres make them adhere to one

another and it is this which gives the thread strength and elasticity.

Among primitive people spinning was done entirely by hand without any implement. A stick was used to wind round the thread. From the simple stick was derived the spindle which is a thin stick, tapering at one or both ends and is usually weighed with a whorl at either end. The whorl acts as a fly wheel and maintains the momentum of the spin. The stem above the whorl has either a hook or grove in it. The spindle is generally made of wood but bone, ivory and metal can also be used. Similarly whorls may be made of stone, pottery, bone or shell.

Spinning seems to have been quite common at Mohenjo-daro. This is indicated by the finding of numerous spindle whorls in the houses of the poor as well as the rich. These whorls are made of various materials such as faience, pottery or shell, though mostly they are made of pottery. The pottery whorls have one, two or three holes in the middle. Whorls with one hole are very common and their finish is rather crude. Some of them have been cut out from broken pottery and are then roughly rounded. They vary in size, average being 1.25 inches in diameter. The spindle used in the whorl which had one hole only, was perhaps just a plain wooden stick. In the two-holed whorls, a spindle made of partially cleft stick would have been used whose sharpened ends fitted into the narrow holes. The whorls with three holes have been found only in the Indus Valley and not in other contemporary civilizations.

TEXTILE PIECES

Except for two very small pieces from Mohenjo-daro no other woven textiles have been recovered. These small pieces were found wrapped around a silver vase. They remained preserved because they had adsorbed silver salts. One of them measured just about 0.3×0.1 inch. The other was also similarly small but it could be calculated that it had 44×43 threads per square inch.

The fibre of these two pieces of textile showed typical convoluted structure characteristic of cotton of the varieties Gossypium arboreum or sanguineum, neglectum indicium or cernuum. This cotton resembles the coarser varieties of Indian cottons which are available even now.

9

Pottery and Allied Industries

The word 'Pottery' in its widest sense includes all objects fashioned from clay and then hardened by fire. Pottery is dependent on two important natural properties of that great and widespread group of rocky or earthy substances known as clays, *viz.*, the property of plasticity and the property of being converted when fired into one of the most indestructible of ordinary things.[33] Specialists in pottery examination can place even the broken pieces—potsherds—to almost their exact age and place.

Pottery of the Harappā civilization, whether at Mohenjo-daro, Harappā, Chauno-daro, Lothal etc. has its own characteristic features by which it is easily recognizable. It is simple and repetitious in form and decorations. There is hardly any change in its form or structure in the successive phases of these cities. It is turned on the wheel and is excellently baked, even better than much of the pottery of the modern times in India. Almost 90 per cent of the household utensils found are made of pottery. Besides these utensils there are burial jars, beads and personal ornaments, toys and other play-things.

A close examination of the pottery objects of the Harappāns, discloses as follows, the materials used and the techniques employed in its manufacture.

POTTERY CLAY

Clay from different areas differs widely in its suitability for making pottery. That which is highly plastic and holds water, though convenient for working, is liable through excessive shrinkage to crack during drying or firing of the pot and must there-

fore be 'opened' by mixing it with non-plastic materials. Sand is often used for this purpose or carbonaceous materials such as chopped grass, cinders or even dried cow-dung.

Majority of the pottery objects of the cities of Mohenjo-daro and Harappā are made of clay which after baking turned pink or light red in colour.

Second type of clay employed was that which after burning turned grey. Whether the colour of the pottery made from it was natural or was darkened by admixture with some carbonaceous material is not certain. Various shades of grey ware, however, suggest the later possibility. Such pottery pieces have also been termed as 'Grey Ware'.

A third kind of clay used at Mohenjo-daro produced a ware of a very light pink colour and very compact in texture. This type of clay does not seem to have been tempered with any other material.

TEMPERING MATERIALS

The above-mentioned clays, particularly the first variety, have been found to contain sand or lime either singly or together with mica as tempering materials. Mica is very commonly found and it betrays itself by its sparkle. It is useful because it binds the clay and it also facilitates drying of the pottery without causing it to crack. Lime is also found in the Harappān pottery and sometimes it is found in rather large lumps.

POTTERY WHEEL

It is certain now that at Mohenjo-daro and Harappā pottery wheel was used even long before the flourishing periods of these cities. None of these wheels have, however, survived or been recognized.

As we know, the function of the pottery wheel is to supply centrifugal force to a lump of well-kneaded plastic clay placed at its centre. Such a lump while spinning fast, 100 or more revolu-

tions per minute, needs only a little guiding pressure from the potter's hand to rise and assume any sectionally circular form he may wish to impose on it. So instead of expending his own muscular energy in pressing, moulding or coiling the clay, the potter merely directs the energy imparted to the wheel.

The pottery wheel is essentially a centrally pivoted or socketed disc of wood, stone or clay on a wooden frame. It is heavy enough to retain its momentum when set spinning. It is started with a bare hand of the potter or by a jerk with a stick that engages in a notch or spoke near the rim of the disc. This is the hand-wheel. There is another type, the foot-wheel that is worked by the foot. Once started, it generally spins long enough for the potter to make a small pot.

The pottery wheel used now-a-days in large parts of India resembles a cart wheel. It is made of wood and its rim is daubed with clay so as to balance it. In the centre of the lower surface is fitted a stone with a small hole in its middle into which is placed the wooden pivot set in the ground. Wheel revolves at a height of four to six inches above the ground and is set in motion by the hand with a stick inserted between the spokes.

Foot-wheel or 'quick-wheel' as it is sometimes called, is used only in Punjab and Sindh. It has many advantages over the hand-worked one.

In the absence of an actual specimen, it is difficult to be certain whether the hand or the foot-wheel was used by the Harappāns. The evenness and the regularity of the striations on the pottery have, however, been considered as indications for the use of a foot-wheel.

DRYING AND BURNISHING

After an object has been moulded on the pottery wheel, it is allowed to dry up in the sun. To avoid cracking, this drying has to proceed at a steady temperature.

When the clay becomes fairly hard after drying, burnishing is done to reduce the porosity of the vessel. This consists in the application of mechanical friction to the surface with the aid of a

smooth pebble or any other handy implement so as to close the surface pores. Effectiveness of burnishing or closing of the pores depends upon the fineness of the clay burnished.

SLIPPING

After burnishing, the pot is first dipped in or painted with a solution formed by the finest portion of the clay used in making the pot or any other clay whose extent of contraction on drying is similar to that of the clay underneath, otherwise the slip is liable to peel off.

Slipping serves two purposes; it helps in closing the pores and secondly, the smooth surface that it provides is helpful in painting a design onto it later on.

The colours of the slips used at Mohenjo-daro were buff, cream, pink and red. The first two colours seem to be the natural ones. The pink slips vary in shades, the light shades appear to be due to a trace of iron in the clay which on firing threw a pink colour. The darker shades, however, seem to have been produced by the addition of a slight red colouring. The red slips seem to have been produced either by mixing red ochre with the clay or by using red ochre itself in solution as a slip. Dark red colour of the slips seems to have been derived by the use of red oxide in the slip.

Red ochre was the most widely used mineral pigment. The term, 'ochre' refers to a large class of natural pigments with colours varying from red to yellow, consisting essentially of hydrated iron oxides, often diluted with clay.

TRIMMING

Vessels and other objects of pottery recovered from the Harappān sites show evidence of trimming with a sharp object at their lower end. This was done to make the base stable. This operation was probably necessitated by the fact that the detachment of the vessel from the main mass of clay, after it had been moulded,

was done by means of a thread or a firm blade of grass and where exactly this detachment occurred could not be seen while this operation was being carried out. Similar technique of detachment of the vessel from the clay on the wheel is still used.

FIRING

Pottery of the Harappān civilization is well-baked. The uniformity of the colour of the vessels and rarity of over-baked or under-baked ones, shows the control that the potter had over the firing process. Vessels and jars as thick as 1.02 inches are correctly baked throughout their thickness.

Firing leads to several chemical changes in the clay of the pottery. These changes depend upon the composition of the clay, the temperature and rate of firing, and the gases that come in contact with the pots. Firing of the pottery can be done in either the open fire or in the kilns wherein a better control over firing is obtained. The minimum firing temperature that drives out water from the clay is between 450 to 700°C. At this temperature the clay particles remain unfused but still this much firing is found workably adequate. Optimum temperature required in open firing of the pottery vessels, however, is between 750-800°C.

KILNS

Excavations at Mohenjo-daro have revealed kilns that still have in or around them pottery pieces. This indicates that they were used for baking pottery. These kilns have a hole below for the fuel and a doomed compartment above to hold the vessels to be baked, communication between the two being effected by round holes in the floor of the upper chamber. Such kilns conserve heat better and require less fuel to reach to an optimum temperature. Improved draught-control results in more uniform quality and permits adjustment of colour and other desired effects.

PAINTED POTTERY

While most of the Harappān pottery whether at Mohenjo-daro, Harappā or Chauno-daro is plain, the painted wares are by no means uncommon. In this painted pottery, the monochrome *i.e.* having one colour only besides the colour of the slip, is the commonest. Polychrome pottery that has more than one colour, is rare. In the monochromic painted pottery, the designs such as the hemispheres, triangles etc. were done in black on a dark red slip. This characteristic 'Red and Black' pottery of Harappā civilization is easily recognizable from other similar ones belonging to the neighbouring village settlements.

Black pigment used for decorative designs was manganiferous haematite which burns into various shades of purplish black, depending upon the amount of iron contained in it. The same material is still being used for the same purpose. For the polychrome pottery, red ochre was used. Sometimes a green pigment and white gypsum were also used.

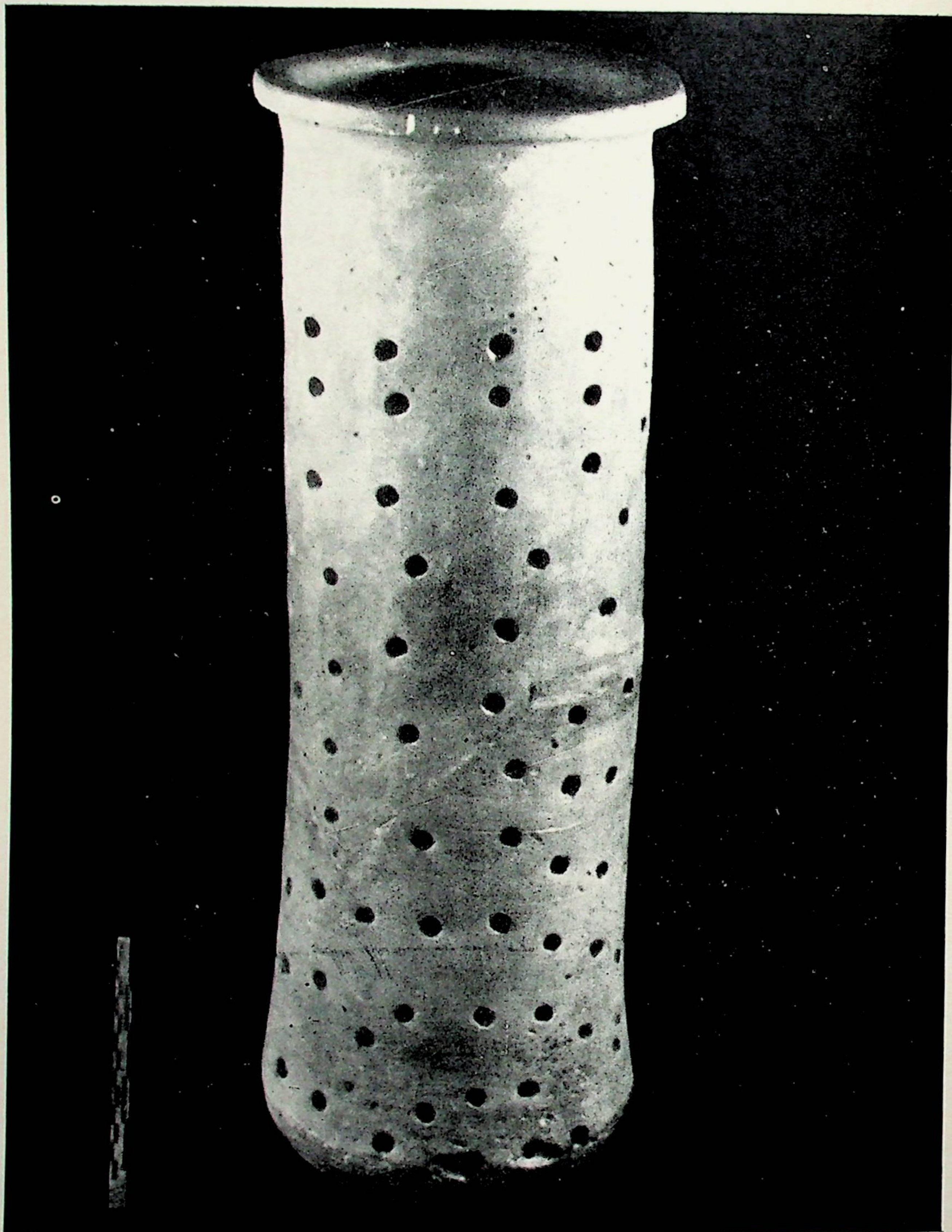
For application of these paints brushes made of varying fineness of hair were used. It looks that sharpened reed points were also used to draw lines.

GLAZED POTTERY

The earliest specimens of glazed pottery in the world have been found at Mohenjo-daro. Glazing pottery is a difficult process. In Egypt it has not been found in times earlier than the Roman. Even at Mohenjo-daro only four samples of glazed pottery have been found and they have been judged to be the work of a high technical skill.

INDIVIDUAL POTTERY OBJECTS

A brief description of some of the individual pottery objects as given below, indicates the special techniques employed by the Harappāns in their manufacture and the uses to which they were put to.



Perforated Vessel, Harappā

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Large Storage Jars: They have been found in plenty. They might have been made to hold water, grains, clothing and other similar household goods. Properly covered these jars are rat-and even insect-proof. They have comparatively narrow bases and were intended to be placed in the hollows of the earth. They have been found placed in this fashion below the level of the floor or pavement or just protruding from it.

Such jars when accidentally broken were utilized as drainage jars to receive drain water, as already described.

The exact technique by which these jars were made is difficult to detect by looking at the jars now, as joints wherever they existed were obliterated by trimming on the inside and as well as on the outside during the process of their manufacture. Whatever little indications are available, show that these jars were first built up from a number of strips of clay and then placed on the wheel for the final finishing touches. A few of the jars such as those with angular shoulders were made in two pieces and were then fitted together when wet and turned on the wheel for a final trimming. It is likely that in some cases the neck of the jar was also made separately.

Suspensory Jars: Rim of these jars is pierced with one, two or more holes. Through these holes the cords were passed and the jars were hung from some hook to keep away the ants or other insects entering into them.

Offering Stands: Such objects vary from 3 inches to 2 feet in length. They have an upper pan, middle stem and a lower base. They have been found in plenty ; generally broken but sometimes intact also. It looks they were used for some ornamental or ceremonial function. Some of them have been found amongst the offerings to the dead near the skeletons.

Heaters or Strainers: These cylindrical objects with perforations made with a thin stick in their walls might have been used to strain fluids or perhaps were used as heaters to contain-in the fire and to let the warmth penetrate out.

Corn Measures: These objects were perhaps used to measure corn. Similar objects are still being used in some parts of India for

the same purpose.

Cages: Pottery cages for birds or small animals were also found at Mohenjo-daro.

Mouse-Trap?: A very interesting pottery object, which could very well have been used as a mouse trap, was found at Mohenjo-daro. It is 9.7 inches long, 4.23 inches wide and 4.55 inches high. Its interior is 8.7 inches long and about 3.1 inches high and wide, the enterance being slightly narrower. It looks to have been made on pottery wheel with the usual clay mixed with lime and mica. The base seems to have been flattened later to prevent it from rolling over. Holes were drilled in it in various parts after it had been baked. Three holes in it, averaging 0.3 inch in diameter are situated in a line on the top. One nearest its mouth is walled around by an added piece of clay to a height of 0.5 inch. The other two holes are perhaps, to admit air and light. A hole at the closed end probably took a peg to which was tied one end of a spring made by twisting a cord, the other end being attached to a rod set in one of the holes in the roof of the trap. From this rod a noose would have been passed down through the hole above the enterance which was perhaps, rimmed to prevent fraying of the noose. Through the third hole in the roof the bait could be attached to a trigger.

It is an ingenious little device meant to perform an intricate function.

Dice: A few pieces of dice, all made of pottery, were recovered from Mohenjo-daro. Dice pieces made of ivory with some marks on them were also found at Chauno-daro.

The pottery dice pieces are cubical in shape and range in size from 1.2 to 1.5 inches. Marks on them are, 1 opposite to 2,3 opposite to 4 and 5 opposite to 6. These dice pieces are very well made and finished and have well-defined edges. The marks on them are shallow and average 0.1 cm. in diameter. The clay of which these are made is light-red in colour, is well-baked and is occasionally coated with a red slip.

Toys: Among various play-things made of clay and baked later on, were the whistles and the rattles. Whistles are shaped in

the form of different birds. They are interesting in the sense that those found at Harappā are still being made in the Punjab villages. These are hollow from within and are provided with a hole usually at the tail-end.

Pottery rattles have been found at Mohenjo-daro as well as at Harappā. They are spherical and vary in size from 1.4 to 2 inches in diameter. In the hollow inside was placed a pellet of clay wrapped in a combustible material. On firing the combustible material burned and the pellet got baked alongwith the rattle. In some specimens there are a few perforations on one side to increase the intensity of the sound.

Pottery Beads: Pottery and terra-cotta beads have also been found. They were more at the upper than at the lower levels. Their holes were perhaps, made by moulding the bead on a piece of fibre which burnt away when the bead was baked.

FAIENCE AND FAIENCE OBJECTS

The name 'faience' has been derived from the town of Faenza in Italy, where this material was first prepared in historic times. There is evidence to show that in ancient times also, this material was made and used in many countries such as India, Crete, Mesopotamia and China.

It appears that the Harappān faience-workers manufactured this material out of a paste of quartz-sand mixed with lime and a bit of soda. This paste was put under pressure in moulds of different shapes and the moulded objects were dried in the sun. They were then placed in a glaze consisting of sand, soda, borax and lime, along with metallic compounds such as of copper, iron and lead to give desired colour to the glaze. After the glaze had soaked through, these objects were placed in furnaces.

The Harappāns made and used faience in several different colours. Blue coloured faience was used for making beads. It was of two types. One in which the colour went right through the bead; for making which the colouring matter must have been mixed with the quartz grains in the original material. Second, in

which the colour is only present superficially. Here it looks the colouring was put on the surface before the faience was moulded into a bead. Yellow coloured faience was also used for making beads and this colour seems to have been produced by a glaze that was put on after the bead had been moulded into shape. White and black coloured faience, as also the variegated one—in which one colour alternated with the other—was also used.

Besides the beads, other personal ornaments made out of faience were cones, ear-studs, bangles, spacers, terminals, rings, buttons, amulets and pendents. All the objects made of faience recovered from Harappā and Mohenjo-daro are generally small in size. Their beauty indicates that the faience-worker of the Harappān times was very skilled one indeed.

VITREOUS PASTE AND OBJECTS

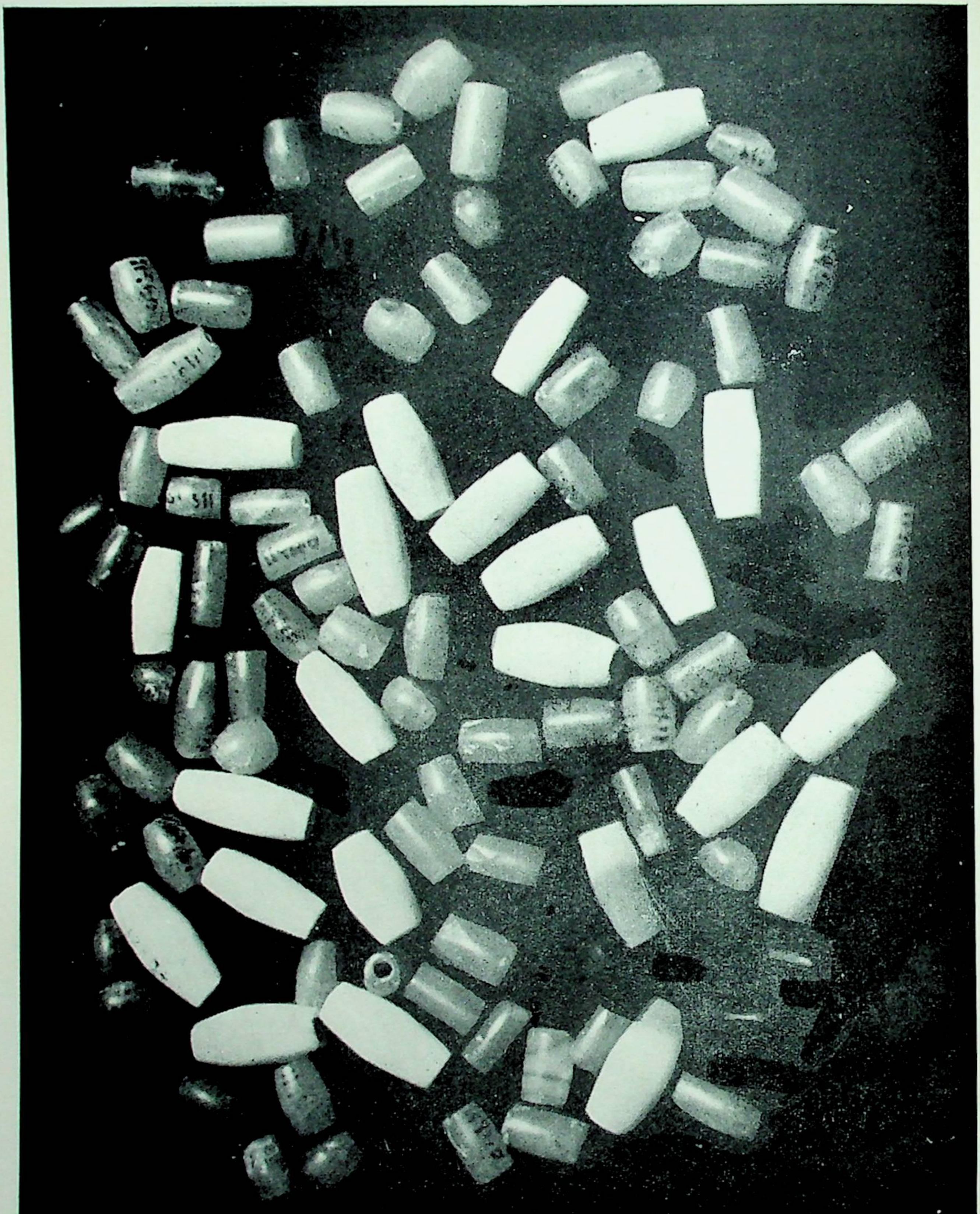
It resembles an opaque glass in appearance and is more compact and sturdier than the faience. It was perhaps, made by mixing glaze with the faience paste beforehand. The objects moulded out of this mixture were then fired at a very high temperature so that the material vitrified. The finished objects show well-defined details.

Two small slabs of this vitreous paste recovered at Mohenjo-daro show their composition as follows : silica 88.12%, alumina 3.27%, ferric oxide 1.82%, calcium oxide 1.26%, alkali oxides 5.04%, cupric oxide 0.46%.

Objects made out of vitreous paste have been discovered only in the Harappān India and in no other contemporary civilization. Hence it can be said that vitreous paste originated with the Harappāns.

GLASS

No specimen of a true glass has been found at Mohenjo-daro or Harappā. The earliest samples of true glass have come only from Egypt.



Beads, Lothal

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BEADS AND BEAD-MAKING

A large number of beads of different sizes, shapes and materials have been recovered from almost all the sites of the Harappān civilization, more so at Chauno-daro, Mohenjo-daro and Harappā. These beads were used for making personal ornaments worn by women and perhaps by men also. Some of the beads recovered are in different stages of manufacture. A few of the implements used for making them have also been recovered.

Bead-Factory at Chauno-daro: At Chauno-daro, a building 33 feet long and 12 feet 6 inches wide, was unearthed in which a series of well-built flues *i.e.*, channels for conveying hot air, averaging 5½ inches wide by 8 inches high, were found. In the same building were found a large number of unfinished steatite beads, a number of copper, bronze and stone tools, and ingot of copper, some cornelian nodules, a shell and a cup. The whole set-up looks to have been a workshop of bead and metal artisans.

Excavations in the adjoining areas also showed some unfinished stone weights and unfinished seals. All this indicates that many of the inhabitants here were artisans who made beads and other metallic and stone objects.

Study of these beads and the implements throws some light on the techniques known and applied by the Harappāns.

Steatite Beads: A vast majority of the beads are made of steatite or a paste made out of the powdered steatite. It is, however, quite difficult to distinguish between the two. It looks that the steatite paste was made into blocks and the beads were carved out of them, as was done in the case of the natural stone. Beads made of steatite paste are, however, very hard. Their hardness has been measured to be approximately three units and in some cases it is as much as six units. In comparison untreated steatite has hardness of only one and a half units. Almost all these beads are white in colour, but this whiteness is not uniform throughout. Probably this whitening effect was obtained by some special process of firing.

Majority of these beads were glazed either blue or green

initially but at present much of the colour has faded.

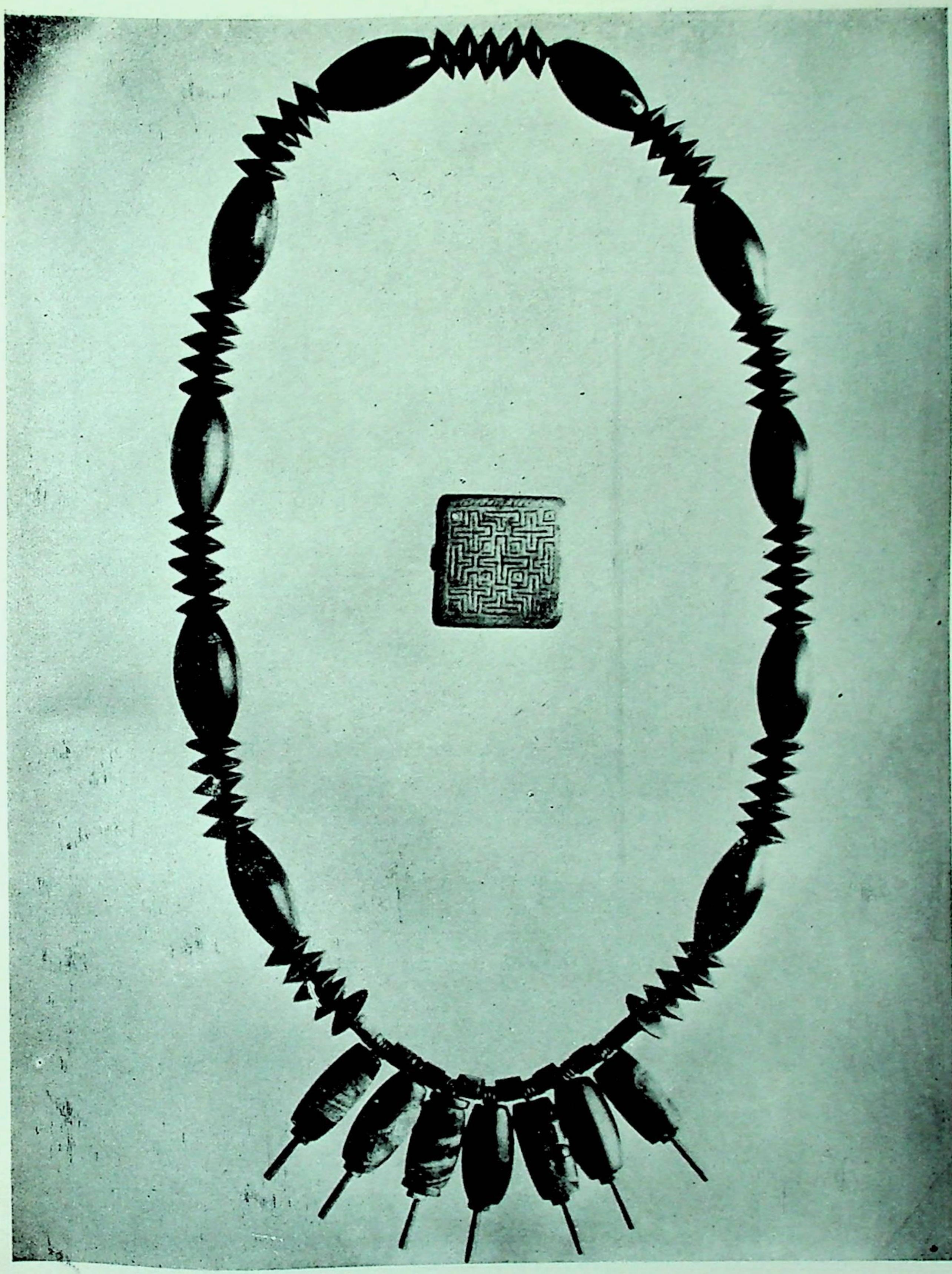
In size the smallest of the steatite beads are as small as 1/40th of an inch in diameter. Such small beads in stone indicate the high technical skill of the Harappāns. They have not been discovered from any other ancient civilization.

Painted Steatite Beads: These beads are a technical marvel. They have a white background on which the paint is red or brown. How the Harappāns achieved this effect is not known, but experimentally similar red paint effect has been achieved by the application of a grease on the white portions intended to be painted, on top of which was put ferric nitrate after which the bead was placed in a heated crucible packed with magnesium oxide. Similarly a dark brown paint could be produced by the use of a mixture of ferruginous clay and caustic soda instead of the ferric nitrate, other procedure remaining the same.[34]

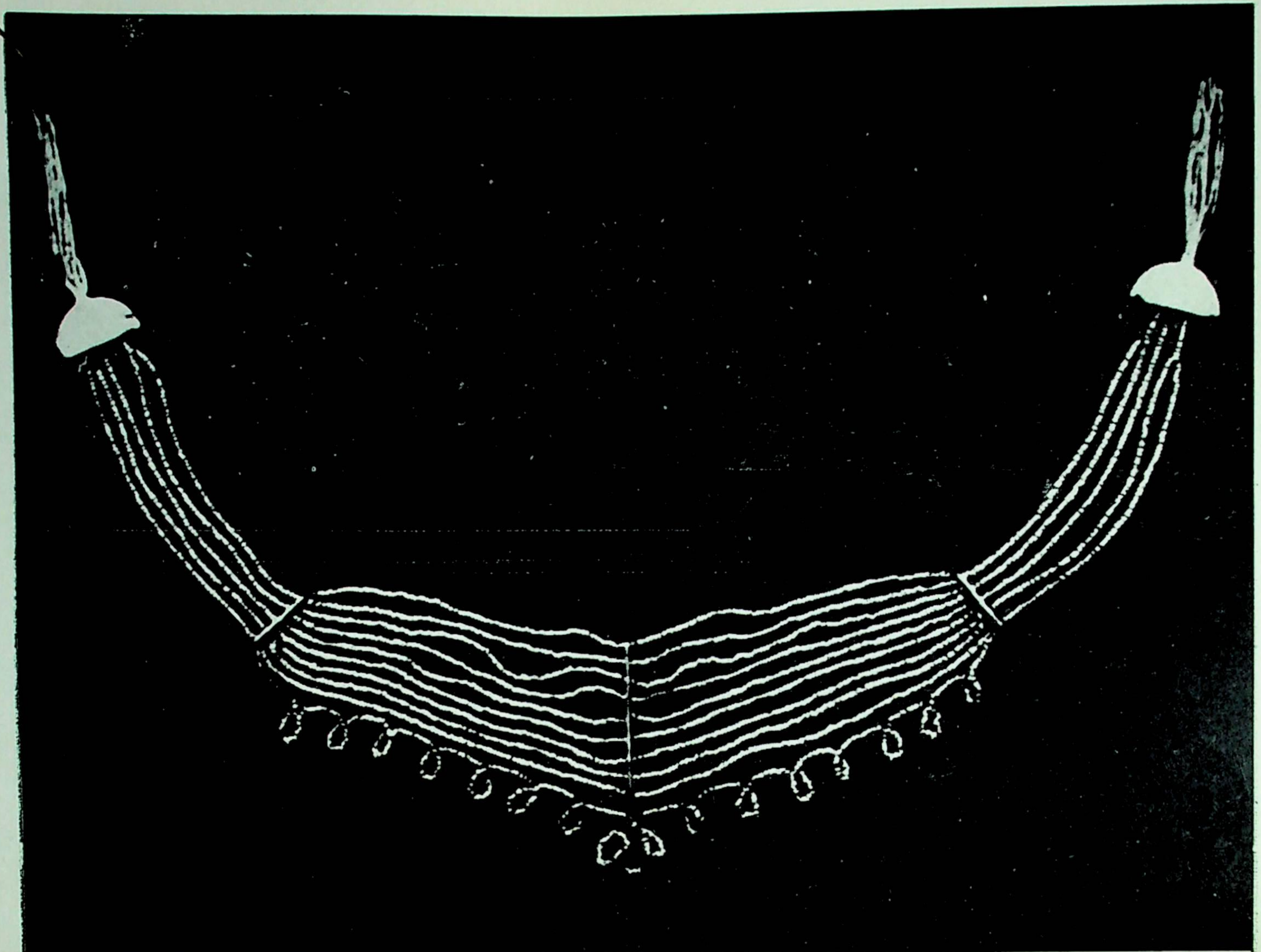
Silicate Stone Beads: Next to steatite, the largest number of beads are made of silicate stones of transparent and opaque varieties ; the transparent silicate stones being colourless quartz or rock crystal, amethyst, yellow quartz or cairngorm, smoky quartz and the opaque ones being agate, carnelian, chalcedony, chert etc. The opaque varieties of beads and particularly those of agate are by far the commonest.

Etched Stone Beads: These beads also indicate the intricate processes used in their manufacture. One of such beads is made from carnelian and it has a design etched upon it in white lines on the natural colour of the stone. How the Harappāns did this is not known but in the laboratory this has been achieved by drawing the pattern on the stone with carbonate of soda and then heating it red hot. A chemical change occurs in the material and the soda particles enter into the stone as minute opaque white spots.

In another variety of etched bead, whole of the surface is whitened over to a considerable depth and then a design in black in etched on the top. In the laboratory this could be achieved by treating the stone with carbonate of soda as above, and painting lines on the surface with a metallic nitrate which turns black when the bead is fired.



Bead Neck-lace, Mohenjo-daro [To face page 104(*a*)



Bead Neck-lace, Lothal

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PERFORATION OF STONE BEADS

Various techniques seem to have been employed for this purpose depending upon the size and the material of the beads. In long beads boring was done with the help of a copper rod drill and a fine abrasive powder. Such a drill when placed in a perfectly straight line with the bead and an optimum pressure applied, makes a nice perforation. It is possible that the Harappāns used such a drill fixed in a bow.

Perforations were also made with a hollow-ended drill. In some cases perforations were made from both the sides of the bead so that the holes met in the middle and produced an hour-glass like perforation.

10
Metallurgy

Metals like gold, silver and copper had been in use in earlier chalcolithic times also, over large parts of India such as in Gangetic valley, Peninsular India and north-western part of the Indian sub-continent. Such chalcolithic communities still existed in some parts of India, contemporary with the Harappāns. The urban Harappāns, however, had come a long way ahead in the technology and use of various metals and their alloys.

Metallurgy with the Harappāns did not remain a part time job for all people, but had become a specialist's job with all the new and intricate techniques involved in it. It even created need for division of labour and for splitting up of the profession into two: one for looking and obtaining the metallic ores *i.e.* prospecting and mining, and the other for working on such ores *i.e.* the metallurgy proper.

Among the metallurgists also, further specialities appeared—the smelters whose job was to produce crude metals or alloys from the ores, the black-smiths who manufactured products from crude metals and finally the fine metal-workers who made ornaments and other objects of art. In the last category, there were even further sub-specialists *i.e.* the gold-smiths and the silver-smiths etc. They are known to have achieved skill in no way less than that of their modern counterparts.

Excavations at Mohenjo-daro, Harappā, Chauno-daro, Lothal and other Harappān sites have revealed that from the earliest to the last phases, the inhabitants, though unfamiliar with iron, were well-acquainted with other metals like copper, bronze, tin, gold, silver, lead and antimony. They used these metals for the manufacture of their utensils, implements, weapons etc. The most

important find of such metallic objects was from Harappā where a large hoard of copper and bronze implements and other objects of daily use were discovered contained in a copper vessel. All these objects are well-preserved and even the original marks of the tools on them or of the wear and tear are still visible.

Examination of these metallic objects and implements, recovered from different Harappān sites, shows the familiarity of the people with the following materials and methods employed in their making.

PREREQUISITES OF METALLURGY[35]

There were four minimum essentials with which the Harappāns must have been familiar.

1. Ores
2. Fuel
3. Air-Blast
4. Tools, crucibles and furnaces etc.

Ores: Ores of different metals have not been found in or around the cities of Mohenjo-daro and Harappā. It may be that some of the ores of copper, lead and silver occurred in Rajputanā, where settlements of Harappā civilization existed at that time and the Harappāns smelted these ores there and exported the crude metal to these metropolitan cities. It also seems that some of the metals were imported by the Harappāns from Baluchistān, Persia etc. Early transport difficulties must have sent smelters near the mines and in turn the traders brought the crude metals to the cities.

Fuel: Wood as fuel existed in plenty in and around the cities of Mohenjo-daro and Harappā and there seems never to have been dearth of this material.

Air-Blast: Air blast is required in metallurgy mainly for the smelting of ores. It is also needed when higher temperature is required over a particular spot of a metal. A blowpipe is eminently suited for this purpose and is still used by gold and silver-smiths. It produces a strong air-blast which can be easily focussed on a particular spot of a glowing charcoal so that a

heated air-blast in turn is directed at the requisite spot of metal.

It may be that for this purpose bellows made from an animal's skin was used by the Harappāns, as was done by their contemporaries in some other parts of the world. Skin bellows is prepared by sewing together the skin of an animal, usually a goat, attaching a pipe and tuyere to one of the legs and using a slit with two wooden rims as the opening for introducing fresh air into the bag.

Tools: Lot of chisels of different sizes and shapes, axes, adzes, saws etc. were recovered from the Harappān sites. No tong, which works on the principle of a hinge, has been discovered. For anvils, they might have used wooden or stone blocks.

A few pieces of crucibles made of clay mixed with sand were recovered. To some of them metal was still attached.

Metallurgical Furnace: A furnace is a contrivance in which the metallurgical operations are carried out under the influence of heat derived from combustion of some kind of fuel. Temperature in such a furnace varies according to its shape, size and the purpose for which it is needed. A furnace consists of two essential parts: (1) the fire-box in which the fuel is burnt and (2) the hearth in which the actual operation is carried out. In many primitive furnaces these two parts were actually one.

Furnaces at Harappa: Sixteen furnaces in three different shapes have been found in one area at Harappā. One of them was made out of a pottery jar, embedded in earth. Fuel used in it seems to have been cow-dung and straw. Two other furnaces were cylindrical in shape with diameters of 3 feet 4 inches and 3 feet 5 inches. These were paved and lined with bricks laid on edge and their walls were mud-plastered. Vitrified slags in them indicate the intense heat which was generated in them. As the vitrified walls in one of them do not go much lower than the point of inlet of the flue or the hot air channel, the latter seems to have been used as an air-channel worked by bellows from above. It is possible that there was another channel in the vault above the furnace which was used as an outlet for smoke and could be closed whenever necessary. Such cylindrical furnaces dug in the ground are still used by village smiths sometimes. The

Two Ovens, Kalibangan

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rest of the thirteen furnaces recovered are pear-shaped, eight of them are lined with burnt-bricks and the five others are mere pits dug in the ground.

A few well preserved metallurgical furnaces have also been recovered recently from Kalibangan.

METALLURGICAL OPERATIONS

Following metallurgical operations were known and employed by the Harappān metallurgists.

Mechanical Operations: These are hammering, forging, cutting, bending, rimming and punching etc. of the metal. The technique of making circular wire was not known to the Harappāns. For making needles they cut the sheet metal length-wise and made rectangular-shaped needles. To make provision for threading it, they bent one end and approximated that with the shaft.

Heat Treatment Operations: Annealing is the process by which a previously hammered and thus hardened metal when heated again becomes soft and easily hammerable. Effect of hammering or bending a metal is that the crystals of which it is composed become distorted and strained. If it is continued on for long, cracks can develop in the metal. However, under the influence of heat, though the external shape is not changed the crystals rearrange themselves so that they are no longer under strain and the metal becomes soft again and the hammering and other work can proceed easily.

Casting and Moulding: When metal is subjected to such an amount of heat that it melts, pouring it into moulds lets it acquire the shape of that mould. This process is called casting or moulding. Open mould casting is the earliest method that was practised and for this purpose clay moulds or even stone moulds were used. The method of open mould was later replaced by a better one called *cire perdue* or wax-casting process. At the same time solid casting was replaced by hollow casting in which a core made up of oiled sand or clay was used. This was particularly

useful when a huge structure was to be cast as for example figure of a god, which if cast solid, would need a lot of metal.

Joining Methods: Soldering is the process of joining two pieces of metals by means of another metal or alloy which has a lower melting point, so that on heating the three, the latter melts and flows in between the two pieces of metals intended to be joined and then solidifies when taken away from the source of heat. Soldering of gold and silver, which is a difficult process, was very well known to the Harappāns.

Welding is the process of joining separate pieces of metals by heat without the intervention of a soldering metal.

Among the Harappān utensils, the dishes and their covers are cleanly made, so much so that they must have been either carefully rubbed down or made on a sort of lathe.* No lathe marks are visible but they could have been removed by subsequent honing and polishing. The handle was secured to the cover not only by a rivet, but also by pouring molten metal around the base of the rivet for additional security. This process is known as 'running on' and is one which requires skill to perform. Rims of these vessels are not strengthened by turning the metal down a little all the way round. Flaring of the rims was, however, practised which does produce some amount of stiffness in them.

There were certain other operations used particularly by gold- and silver-smiths, which will be described later.

METALS USED

Copper and its Alloys: Copper used by the Harappāns must have been derived from its various ores. Ores of oxide and carbonate of copper can be reduced to copper by application of heat at a temperature around 600-700°C. Such high temperature

*A lathe works on the same principle as a drill, but differs from it in two respects. In the lathe, the work and not the cutting tool, is rotated and the spindle is horizontal and not vertical. This horizontal arrangement of the spindle almost inevitably involves the use of a second bearing or support, in addition to the socket in which the butt moves.

cannot be produced in an open fire but is easily obtainable in pottery kilns which were already available around 3000 B.C. and could serve this purpose very well. It is highly probable that these copper ores were smelted in such kilns.

No copper ore as such has been discovered at the Harappān sites. It has been suggested that copper was imported from Rājputanā, Baluchistān or Persia where the copper ores existed in ancient times and where they were reduced, and copper as such was brought to Mohenjo-daro and Harappā. Here the metal was remelted, purified and refined and then objects were made out of it. Lumps of such crude metal plano-convex in shape, 6 to 9 inches in diameter and 1 to 2½ inches thick in the centre, weighing about 6 to 8 pounds have been found at Mohenjo-daro. A fragment of a crucible with copper slag sticking to it, was also found.

Bronze: Copper as such is a comparatively soft metal and so is not very useful for making tools and weapons requiring hard edge. But in combination with tin in the form of bronze, it acquires strength, elasticity, toughness and ability to withstand shock. This fact seems to have been well understood by the Harappāns. They made their celts, chisels and other tools with this bronze.

It is interesting to note that while bronze containing 4 to 8 per cent tin can be forged only by frequent annealing *i.e.* heating and hammering, the one containing tin above 8 per cent can only be worked at dull red heat owing to its brittleness. Analysis of various bronze objects discovered from Mohenjo-daro shows 4 to 11 per cent tin in them. This clearly indicates that the Harappāns were fully conversant with the various techniques of handling different grades of bronze.

For making different objects such as the utensils, implements, weapons or the pieces of art out of bronze, there are two methods that the Harappāns could have employed.

(1) Beating the bronze sheet into the shape of the object. This calls for constant annealing to prevent the metal from cracking.

(2) *Cire perdue* or the lost wax process. The first stage of this process consists in preparing a negative made of plaster or gelatine,

of the model that is to be prepared. In this negative which shows all the details of the model in reverse, a wax coating is applied in a molten state with a brush until it has acquired sufficient thickness. This provides a perfect replica of the model in wax, and sufficiently hard to permit handling. The artist can work on it as much as he pleases, obtaining rare results of details which make this process of casting invaluable. Finally the mould for the metal is formed by blowing or pouring inside and around the wax a semi-liquid solution which hardens in a few minutes. This solution of silica, plaster and other chemicals can resist high temperature. All the wax inside it melts away, leaving a hollow space. This operation is accomplished in large ovens by baking the mould over a slow fire. As soon as all the wax has melted away, the mould is removed from the oven and packed in foundry earth in a pit provided in the floor. The bronze is then poured from crucibles and the molten metal runs through the apertures and fills the empty space. The figure in bronze is then removed from the silica mould and dipped in acid for proper cleaning. With this process very little finishing or chiselling is needed and the results are far superior in detail.

This process is exceedingly difficult for large and thin castings owing to the risk of flaws and crevices that would render a utensil made in this way non-water-tight. Varying thickness of some of the bronze vessels recovered from the Harappān cities suggests that *cire perdue* process might have been used by the Harappāns.

This method is still being used in India by some of the tribal communities and the objects thus made are highly appreciated as art pieces.

Scraps of bronze that have been discovered at Harappā and Mohenjo-daro carefully stored along with other valuable implements, point to the preciousness of bronze to the Harappāns.

Inspite of all the indications that the Harappāns were familiar with the superiority of bronze over copper for making tools and weapons, the use of pure copper for such purposes still persisted. The only possible explanation of this simultaneous use of copper and bronze is that the supply of bronze was limited and its use,

therefore, was confined to objects of a special nature *e.g.* tools, razors, jewellery or ornamental vases, for those who could afford them.

Copper-Arsenic Alloys: Some of the copper objects discovered at Mohenjo-daro and Harappā contain 5 per cent or even more of arsenic in them. Addition of arsenic to copper adds to its hardness and this is a worthwhile property for making implements and weapons. Such arsenic containing alloys are comparable with low grade bronze in hardness and strength and can be worked either in cold or in hot state.

While amounts of arsenic upto 1 per cent in copper objects might be considered as an impurity, the larger or considerable amounts, up to 5 per cent or more, can only be taken as intentional additions. A lump of lollingite, a natural mineral composed of arsenic and iron, found at Mohenjo-daro could have been meant for making copper-arsenic alloy.

Tin: Tin as such is of no use for making weapons or tools. Its use was mainly in the form of its alloy with copper as bronze. Bulk of this metal in antiquity was obtained by roasting in a furnace its ore tin oxide or cassiterite. This is dark brown or black in colour and heavy in weight. It was obtained by washing the alluvial sand of certain rivers which drew this ore from the rocky mountains containing its deposits.

Tin ore was also found in association with copper ores in certain places, reduction of which provided bronze containing small percentages of tin in it instead of the pure copper.

Lead: A lump of lead, which might have been used as a net-sinker and a few other small pieces, perhaps used as plumb-bobs, were found at Mohenjo-daro. Lead might have come to Mohenjo-daro from Ajmer or from silver mines of Afghanistān or Persiā. It does not seem to have been widely used. Analysis of lead found at Mohenjo-daro shows no trace of silver in it.

Gold: This is perhaps the earliest metal discovered and used by mankind. It occurs either as particles or nuggets of native metal in the rocks or in the gravel and sand of the river beds. Production of gold, therefore, needs only collection of the gold

bearing rock or sand and separation of gold particles from it by crushing, washing, panning and melting it to form a lump.

Since early historic times, gold has been supplied to the rest of India from the south *i.e.* from Hyderabad, Mysore and Madras. Some of the ancient mines there, can still be seen. It looks that the Harappāns also got their gold from there, as many of the gold ornaments found at Mohenjo-daro and Harappā are alloyed with a substantial percentage of silver and this alloy called electrum is said to be found only in the Kolār goldfields of Mysore and at Anantpur in Madras and nowhere else. It is possible that some of this gold was collected from the alluvial sand of the river Indus as well.

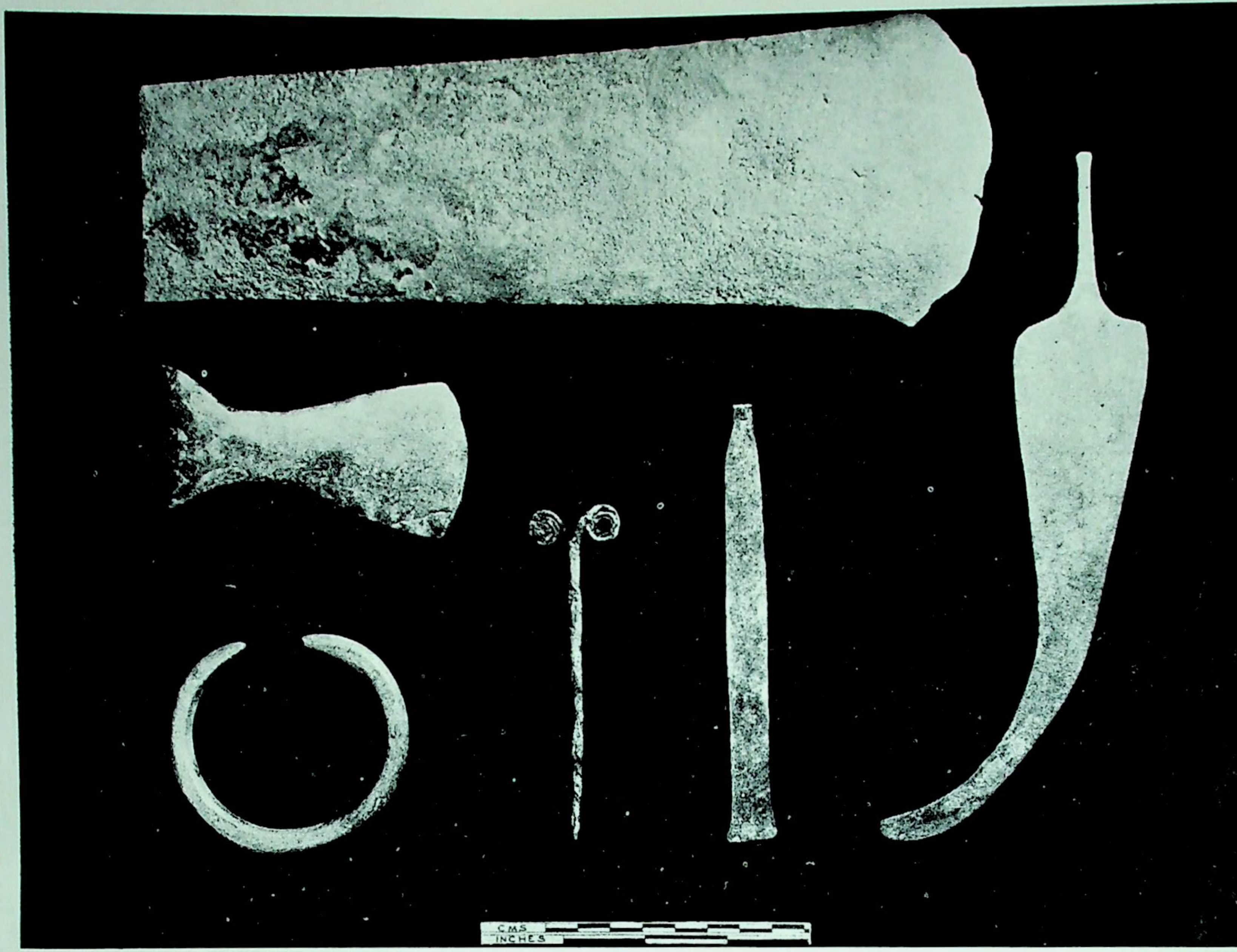
Silver: Though it occurs in the native state also, it is much easier to separate it out of a lead ore namely Galena. Galena in ancient times was used as an eye paint. Its brilliant metallic appearance, high specific gravity and very common occurrence could not have failed to excite curiosity of the early man. When a piece of galena is dropped in fire, lead is produced initially and if this is left there long enough, all the lead burns away and what is left behind is a small drop of silver. It appears that the discovery of silver in workable quantities developed with the production of lead from galena.

Silver, like gold, was also used for making articles of jewellery at Mohenjo-daro and Harappā. Both these are, however, useless metals for making tools and weapons.

WEAPONS AND IMPLEMENTS

The following individual description of some of the metallic weapons and implements recovered from the Harappān sites, chiefly from the cities of Mohenjo-daro and Harappā, gives an idea as to how they were made and also to what use they were put to.

Although it seems convenient to place tools and weapons in categories such as agricultural implements, hunting weapons, war weapons, domestic tools and so on, yet in practice such a classification here would lead to ambiguities. Firstly because we are still



Bronze Tools and Arms, Mohenjo-daro

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ignorant about the true purpose of many tools and secondly some of these tools might have been used for more than one purpose. Hence such a precise classification could not be used here.

WEAPONS

A variety of metallic weapons of different sizes and shapes have been found at Mohenjo-daro and Harappā. These include swords, spears, daggers, blade-axes, maces, slings etc. These weapons seem to have been used for offensive purposes only.

Swords or Dirks: They are one to one and a half feet in length. They are double-edged and their maximum thickness is slightly less than half an inch, which is at the junction of the tang with the blade. Two rivet holes pierce the blade close to the tang. These holes look to have been meant for fixing a wooden handle over the tang. One of these swords 18.5 inches long weighs 1 pound $7\frac{3}{4}$ ounces. Its tang has rectangular-cut sides and it tapers off gradually from 0.39 inch by 0.18 inch to almost a pointed tip.

Knives: They are in different shapes such as narrow and straight, triangular with up-turned points, broad with curved edge, hollow-backed, double-curved and a shape which could at once be of a knife and a dagger.

Spear and Lance Heads: Their peculiarity is that they are very thin. A moderate pressure could easily bend them. It is probable that these heads were fitted in the split end of a wooden rod or a bamboo and secured tight with a rope and an adhesive. The wood where it held the spear head acted as a midrib, providing necessary strength to this frail structure.

Arrow Heads: They are thin and flat with long narrow barbs *i.e.* the lateral projections. As is the case with lance and spear heads, the shafts in which these arrow heads were set must similarly have served as a kind of midrib. They average 1.19 inches in length, 0.64 inch in breadth and 0.07 inch in thickness. They are cut out of sheets of copper or bronze.

Maces: Copper maces, generally pear-shaped, have been found. There were stone maces too.

Blade Axes: An axe has the edge parallel to the handle. Those found at Mohenjo-daro and Harappā, seem to have been made by running liquid metal in the moulds. The casts thus obtained were hammered to give optimum hardness, thickness and edge wherever necessary. Maximum thickness of these blade axes is at about two-third of the distance down them.

These blade axes are of two types: the long and narrow and the other short and broad.

Long and narrow type of blade-axes have been found in large number. They generally have double slopes and crescent-shaped edges that are sometimes slightly splayed *i.e.* turned outwards. The butt or the thicker side is usually straight-cut or very slightly rounded. The sides are almost parallel. No particular economy seems to have been observed in the use of metal in making them. Advantage of this was that when after frequent use they developed blunt and upturned edges, these could easily be hammered into shape again and again.

Short and broad type of axes have not been found often. Their crescent-shaped edges, however, are considerably more splayed than in the long narrow type. These edges have double slope and the butt is square cut and thinner than the rest of the blade. The largest axe of this type is 7.9 inches long and the shortest 2.45 inches.

These blade axes must have been hafted in the wooden handles. This could have been done by splitting the handle or by making a hole in it and then tightening the same with a rope and perhaps also with some sort of an adhesive gum. Whether a portion of the blade projected on the reverse side of the haft and whether the blade was held at right angles to it or was given a slight slope is not known.

Socketed Axes: The first socketed axe was discovered at Mohenjo-daro. It is 10.15 inches long. Its socket is 1.7 inches in outside diameter and 1.45×1.3 inches inside, the inside being somewhat oval in shape. Width of the horizontal blade is 2.52 inches and of the axe blade 3.05 inches. Both have double-shaped edges. Its height from the base of the socket to the top of the

two blades is 2.4 inches and its width above the socket 2.28 inches.

The second socketed axe was discovered at Chauno-daro. It is made of bronze. It is 2.95 inches long and its lunate edge is 1.94 inches wide. Interior dimensions of its slightly oval socket are 0.82×0.71 inches. It appears to have been cast edge down because there is a slight projection at the back of the socket where the metal was run in. It has smooth even well-finished surface.

Another socketed axe, not real one but a model in pottery, was unearthed at Mohenjo-daro. This model is 4.3 inches long and 0.58 inch thick. The dark chocolate colour of the slip perhaps represents copper or bronze and extends right round the back of the handle indicating a socket in it.

The two specimens and the pottery model show that the Harappāns were well familiar with the socketed axes. Socketed adze-axes unearthed at Tepe Hissar (Sumer) resemble closely the above specimens.

IMPLEMENTS

Shovel: Only one shovel has been recovered and it is 16.3 inches long with its handle. Its base and sides are 0.2 inch thick. It weighs 3 lbs. 10½ ozs. The plain flat handle which is of one piece of metal, with the pan is 4.87 inches long, 1.5 inches wide and 0.21 inch thick. Handle has no rivet holes in it.

Chisels: Chisels, in a variety of shapes, are the commonest tools discovered at Mohenjo-daro. They were found in plenty in other places too. They are either made of copper or bronze. According to their size, shape and other characteristic features, they can be divided into the following types:

(1) Long, rectangular or square in section, with a uniform thickness throughout.
(2) Rectangular or square in section with a flattened tang.
(3) Round in section.
(4) Short stout ones either round, rectangular or square in section.
(5) Short pointed ones.

Type 1 chisels are by far the most common. They have a rough finish and vary from 1.57 to 5.2 inches in length. Their edges are abrupt, doubly sloped and occasionally slightly splayed. The butt is a square and rarely burred or flattened due to hammering. It looks these chisels had wooden handles. They were perhaps used for wood work or on soft stones.

Type 2 chisels range from 2.85 to 9.4 inches in length. Their broad rectangular tang which narrows down to a double-sloped edge shows considerable splay. The tang seems to have been encased in wooden handle but the top end projected out so that it is burred due to hammer blows. These chisels are made of bronze. They have been found only in the Indus valley and nowhere else.

Type 3 chisels are rare. They are made of a thick copper wire with a double slope at one end and pointed at the other end. These could have been used on soft stone or on wood.

Type 4 chisels are short and stoutly made. They were perhaps used for metal work or on hard stone. They might have had a handle or were perhaps held between the fingers while working with them.

Type 5 chisels instead of having a flat edge have a point which was perhaps used for preliminary work on stone.

Tubular Drills: The work of drilling hollows or holes in stone was in earlier times done by stone handaxes. It involved twisting and partial rotary movement. For the same purpose, in later periods, were developed points and awls made of stone. Perforations in stone could be made by alternately using them from opposite sides so that an hour-glass like hole was produced. The stone implements for making holes had the disadvantage that they got worn off very soon. So when metals became available, metallic tubular drills were used for this purpose. All these tools have one thing in common, namely the use of partial rotary motion.

Many tubular metallic drills were discovered at Mohenjo-daro, Harappā and Chauno-daro. These drills are tapered tubes of thin copper or bronze. Width of the groove left between the core and the wall varies between 0.05 to 0.2 inch. While the cores are

perfectly cylindrical, the hole itself tapered slightly towards the bottom, from which it follows that the thickness of the tubular drills increased only on the outside, the inside hollow remaining perfectly vertical. Allowing at least a quarter of the width of the groove for an abrasive and for the free movement of the drill, the net thickness of the drills would seem to have varied between 0.0375 and 0.15 inch.

These drills are so carefully made and perfectly rounded that it seems likely that they were shaped on a mandrel *i.e* , a cylindrical rod round which metallic object is forged or shaped. Their edges meet exactly and do not overlap in any way. Probably thin end of the tool was inserted in a wooden handle and it was worked with a bow.

These tubular drills were used to drill holes in stones of different hardness such as chert, basalt, sand-stone and alabaster. The drill holes in these stones were perhaps meant for the insertion of dowel *i.e.*, a headless pin of metal used for fixing the stones together.

Sickle-blade: This copper object, 4.7 × 1.05 inches, has a curvature like that of a sickle. Its outer edge looks to have been used for cutting.

Saws: Made of bronze, they vary in length from 12 to 18 inches and one of them has a breadth of 6.3 inches. In thickness they vary form 0.05 to 0.1 inch. Teeth of the saws are placed irregularly, there being an average distance of 0·72 inch between them. Actual edge of the saw is 0.05 inch. These saws had probably wooden handles which were secured by 2 or 3 large rivets placed wide apart and they enclosed a considerable portion of the blade. These saws must have been used for cutting wood.

Awls and Reamers: They are frequent finds. They vary from 1.5 to 7.7 inches in length. They are made of copper or bronze rod, about ¼ inch square or round in section. Towards the end of the rod, they thin down to a point either at one or both ends. In one of the specimens the shaft has been hammered flat and at the butt measures 0·37 × 0.1 inch with the point bent. These awls were probably used for heavier work than were those made of bone.

Needles: They are made from thin strips of copper and are rectangular. One of them measures 1.3 inches by 0.17 inch transversely. The eye is at the pointed end. They are fairly thick and could have sewn cloth of loose weave. Many of them have been found broken.

Razors: A number of objects found in Harappān cities have been recognized as razors. They might have been used to shave the heads or to remove hair from other parts of the body. According to their shape they can be grouped as follows:

(1) Double-bladed.
(2) L-shaped.
(3) Hook-shaped.
(4) Simple.

Double-bladed razors made of copper are by far the most common. These blades are paper-thin and their tangs are slightly thicker. The two blades of these razors are of different shapes, each side probably had its own function. They are made of sheet metal having been hammered into proper edges. The largest razor is 2 inches across the blade, others are much smaller. The tang does not seem to have been enclosed in a handle.

In the L-shaped razors, one side is larger and broader than the other.

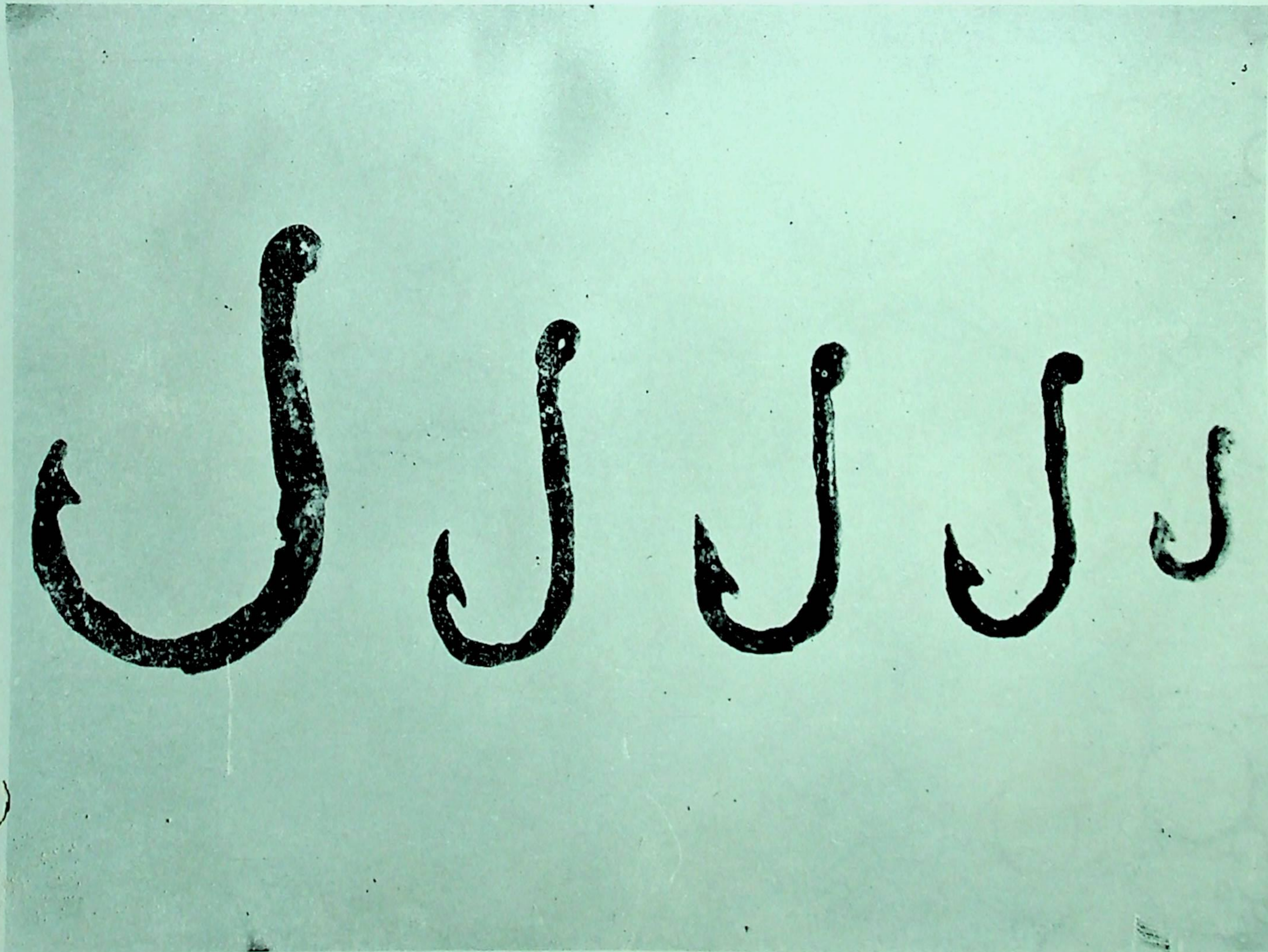
Type 3 and 4 blades are rare.

A Bunch of Instruments: A bunch of three instruments was found at Harappā. Their ends are looped and interlaced. One of them is a double-edged knife 4.4 inches long, the second is a pair of pincers 5.2 inches long, and the third is a piercing rod 5.3 inches long. These instruments might have been used for surgical purposes.

Gouges: Made of bronze with the cutting edge semicircular, they would have been used for hollowing out, grooving or rubbing wood, bone, ivory and stone.

Leather-Cutter: A copper object $6.2 \times 2.1 \times 0.1$ inches with its tips curved could have been used as a leather-cutter.

Fish-Hooks: These are made of sheet copper. They are 0.15 inch thick and about 2½ inches long. A hook consists of a



Fish Hooks, Mohenjo-daro

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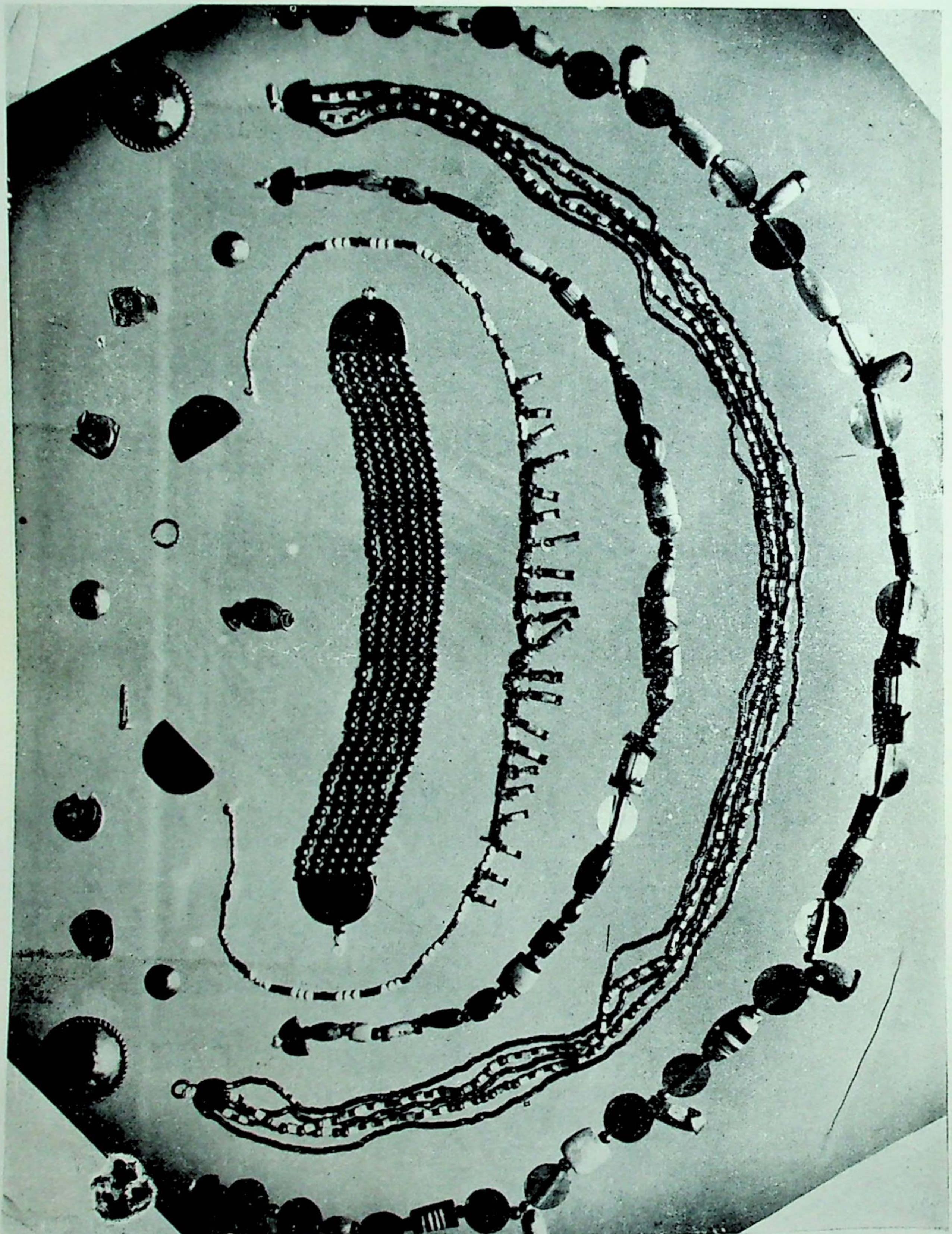


Jewellery, Mohenjo-daro

straight shank slightly thinned out and turned over to form an eye at the top and is equipped with a single barb.

These metallic hooks are the earliest of such specimens discovered anywhere in the ancient world.

Net Sinker: A circular piece of lead 6.7 inches in diameter and 1.4 inches thick with a central hole, recovered from Mohenjo-daro, might have been used as a net sinker.

Bolt: A copper object 25.15 inches long which tapers at one end to a blunt point 0.59 inch wide by 0.37 inch thick and has its head slightly bent measuring 0.98 × 0.92 inches, appears to have been used as a bolt for fastening timber together.

Plumb-Bob: Round lead ball 1.2 inches in diameter with a copper or bronze staple attached to it was most probably used as a plumb bob. It was found at Mohenjo-daro.

Mirrors: They are not made of glass but of bronze. They are slightly oval in shape. One of them has the edges of the face raised by 0.17 inch and the polish has completely disappeared. Their handles are rectangular with a hole at the end and it looks the handles were encased in the wood. These mirrors are fairly heavy. Such metallic mirrors were used in early Egypt, Sumer and Elam also. There they are either round or elliptical but not oval.

FINE-METAL WORK

The term 'fine-metal-work' describes a type of craftsmanship which involves the application of technology to the production of an art. Personal jewellery and ornaments and a few other objects conveniently come under it.

As in most ancient countries, women of the Harappān civilization decorated themselves with jewellery and it is probable that the men also did likewise. While rich people wore ornaments of gold, silver and electrum studded with precious stones, the middle classes had them made of copper, bronze, shell, bone, faience and vitreous paste and the poor ones of terra-cotta and pottery. Gold and silver jewellery was found mainly at Mohenjo-daro and some

at Harappā also. Inexpensive type of beads etc., were mostly found at Chauno-daro.

Personal ornaments comprised girdles, armlets, anklets, necklaces, pendents, bracelets, bangles, fillets for the hair, finger-rings, ear-rings, nose-rings, ear-studs, ornamental pins and buttons.

An interesting piece of fine-metal work is the figure in bronze of a dancing girl discovered from Mohenjo-daro. Her left arm has bangles on it upto the armpit. Her hand on hip, legs tilted slightly forward and the peculiar posture of her body makes it an object of art of considerable worth.

Another impressive object of art is a miniature two-inches high two-wheeled copper chariot discovered at Harappā. It is open both in front and back and has gabled roof. The driver is seated in front on a raised seat. The front portion of this chariot which should have included the yoked animal, the poles, the wheels and the axle, is missing.

TECHNIQUES

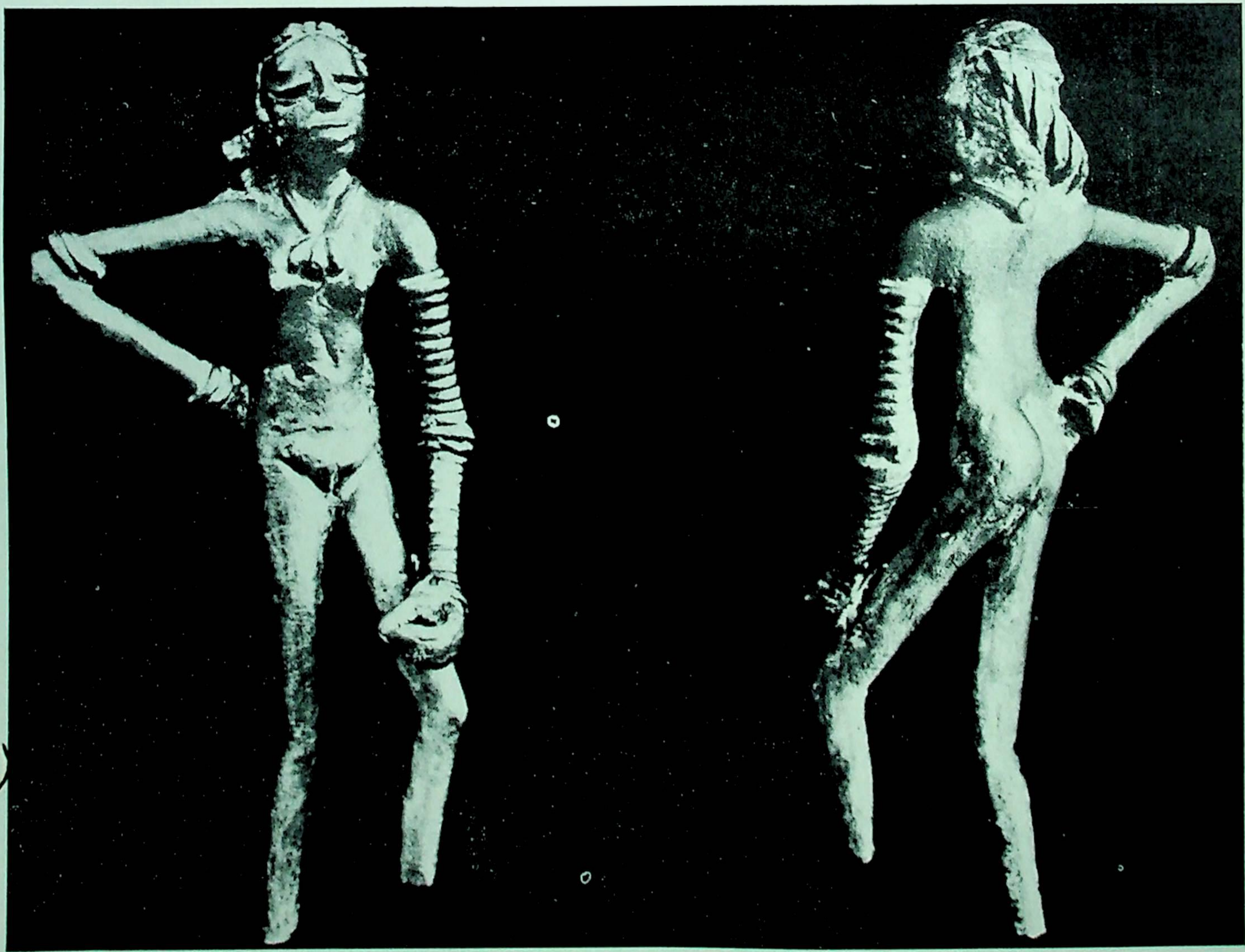
Personal ornaments and objects of art recovered from the Harappān cities indicate that the gold-smiths there were indeed very skilful in their profession. Different techniques which they knew and employed are as follows:

Repousse: It is the process of decorating a piece of metal so as to raise a pattern, in relief, by blows on its underside while its decorated side rests on wood, lead or pitch.

Stamping: It is the process of making identical patterns, in relief, for a necklace or bracelet etc., by filling and grinding the design on the face of bronze or lead and then to lay over it properly annealed gold or silver and driving the same in with a few steady blows so that the exact design is made on the metal to which final finish is given by trimming off its sides.

Filigree and Granulation: These are the processes of decorating a metallic surface by soldering onto it sheet-cut wires or grains of metal.

Inlaying: It is the process of fitting or moulding into a recess



Bronze Statuse, Mohenjo-daro

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or cavity of another material, pieces such as of shell, stone or bone for decoration.

Cementing, abrasion, polishing burnishing are some of the other techniques used by the gold-smiths.

Harappān gold-smiths also made wires of gold. This was perhaps, done by stretching out adequately heated piece of gold through holes of different sizes prepared in the stones.

They also made light-weight but solid looking ornaments in different shapes. The empty spaces in them they filled with lac. They sometimes wrapped this gold sheet on copper or bronze base so as to give the whole thing an appearance of gold.

It looks that the use of these precious metals must have involved the need to find out whether they were pure or not. The Harappāns, most probably, would have found this out by rubbing the metal on a stone and seeing the brilliancy or otherwise of the metallic streak produced thereon, as is done even now-a-days in India. Whether they performed some sort of chemical analysis also, can not be said with any certainty.

TOOLS

Their tools[37] included short stout chisel, short pointed chisel, small saw, copper knife, copper borer, copper drills for making holes, copper spatula, copper tube for blowing fire and hammer stone to make thin sheets out of the ingots. A few of the pots found at different sites resemble very much the small crucibles used by gold-smiths in India.

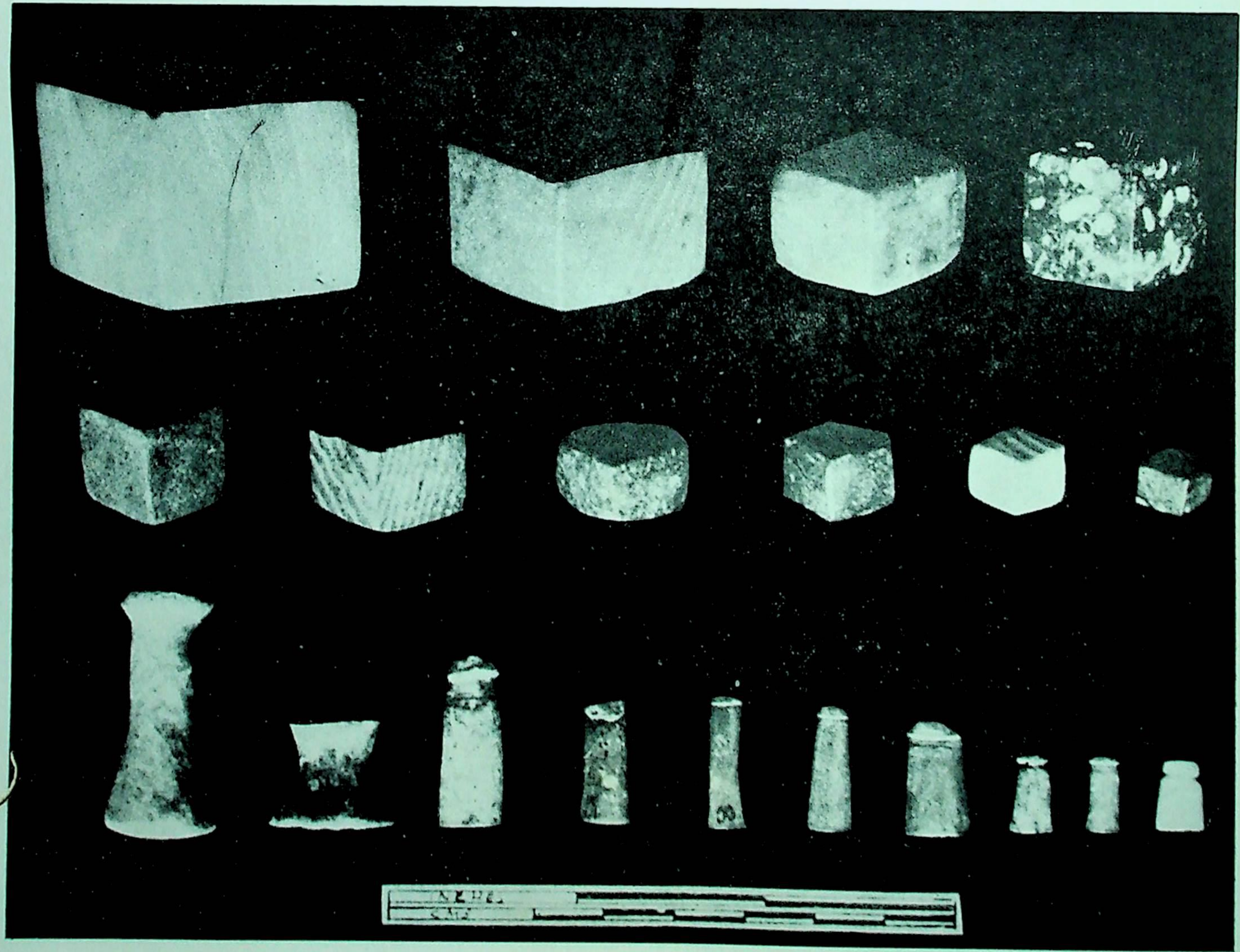
11
Weights and Measures

As man progressed from the stage of hunting and food-gathering to that of agriculture and settled life of the Neolithic stage, trade between different peoples and communities developed on the lines of barter *i.e.*, exchange of one class of goods for another. Later, development of many populous city states with their larger number of items for exchange, found the system of barter insufficient to their needs. This was felt not only by the trading community itself but also by the authorities or kings of the city states who had the responsibility to run smoothly the affairs of their domains. Thus developed the system of standard coins and the measures of weights, lengths etc.

The initial idea of the standard weights and lengths developed on the basis of the standard size of some familiar objects. For weights, it was the number of grains of 'rati' (Abrus precatorius), wheat, rice etc., countermeasured against the object to be weighed. For lengths, it was the length of man's own arms, forearms, stretched hands, breadth of the fingers, length of the feet, total height of man etc. The average length of the forearm, a cubit, and other similar measures still persist in different parts of the world.

WEIGHTS

The earliest commercial use of weights in the world has been found in the ancient cities of Mohenjo-daro and Harappā.[38] A large number of nicely finished and well preserved weights were recovered from all over these cities. These weights are remarkable for their accuracy and preciseness and are better than those



Weights

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of any other contemporary civilization. They clearly indicate the importance given to correct measurement, which is the first essential for any scientific endeavour.

A majority of these weights are made of chert stone which is very durable and resistant to ordinary wear and tear.

To make these weights, the stone was first chipped and then ground and polished to the precise requisite weight. Larger weights have holes pierced in them for lifting them with the rope tied in the hole.

These weights are in different shapes such as the cuboid, barrel, cone, cylindrical or spherical with flattened base and top. Cuboid-shaped weights are the commonest. The smallest weight measures $0.3 \times 0.3 \times 0.25$ inches and this was found both at Harappā and at Mohenjo-daro. The largest weight was found at Mohenjo-daro and it measures $6.8 \times 6.0 \times 3.8$ inches. Their weights in grammes are given in the following table.

COMPARATIVE TABLE OF THE WEIGHTS IN GRAMMES FOUND AT MOHENJO-DARO AND HARAPPĀ[39]

AT MOHENJO-DARO		AT HARAPPĀ	
Mean weight	*Calculated weight*	*Mean weight*	*Calculated weight*
1375	1370	1375	1376
—	—	546.7	550.4
272.95	273.92	—	—
174.5	171.2	—	—
135.5	136.96	135.86	137.60
54.21	54.78	54.32	55.04
27.79	27.39	27.55	27.52
13.79	13.70	13.86	13.76
6.82	6.85	6.84	6.88
3.40	3.42	3.44	3.44
2.28	2.28	—	—
1.77	1.71	1.70	1.72
0.87	0.856	—	—

All these weights have been shown to belong to a definite system which is identical at Mohenjo-daro and Harappā. This

system, generally speaking, is binary in the smaller weights and decimal in larger ones. The weights found at Mohenjo-daro are in the ratio of 1, 2, 8/3, 4, 8, 16, 32, 64, 160, 200, 320, 640, 1600, 3200, 6400, 8000, 128000. The unit weight has a calculated value of 0.8570 gm. The largest weight is equal to 10770 gms.

SCALE BEAMS AND PANS

Not as many scale beams and pans have been recovered as one would have expected from the number of weights that were found. Perhaps they were made of perishable material such as wood etc. and thus have not survived the ravages of time. A scale-beam 6.2 inches long with traces of thread attached at one of its ends was found at Mohenjo-daro. Nearby it were lying two scale-pans. At Chauno-daro many scale-beams were found. None of these scale beams has a hole in the centre to tie a suspending cord.

MEASURE OF LENGTH

A shell rod used for measuring lengths was recovered at Mohenjo-daro. It is broken and incomplete and is 6.2 inches wide and 0.27 inch thick and has nine divisions on it. Average length of one division is 0.264 inch. It bears marks of a dot and a cross in a circle five divisions apart, thus indicating a decimal scale of 1.32 inches. Division lines are carefully etched and are 0.02 inch deep and wide.

Another fragment of a bronze rod used for measuring lengths was discovered at Harappā. It is 1.5 inches long and 1/8th of an inch in diameter, broken at both ends. It bears only four complete divisions marked off by V-shaped indentations. The length of each division is 0.960, 0.905, 0.925 cms., averaging 0.934 cm.

A measuring rod made of ivory about 7 inches long, graduated along the upper margin, its each division being 1.7 mm in length, was found at Lothal.

The precise measures of weights and lengths known to the

Harappāns, mark the beginning of scientific methodology and invention. They must have been of immense help to the metal-workers who had to measure precise quantities of different metals to make alloys with requisite properties. The same must have been the case, I suppose, with the medical practitioners who also have to measure exact quantities of herbals or chemical compounds to make medicinals for the patients.

12

Harappan Seals

Over 2000 seals have been recovered from the Harappān sites, chiefly from Mohenjo-daro and Harappā. A vast majority of them are made of steatite stone. Other materials used are faience, ivory and pottery. They are of different sizes and shapes, square and oblong ones being the commonest. They have a protuberance or a boss on the reverse side which is pierced through with a hole meant perhaps for passing in the thread to suspend the seal. The front side which is flat is engraved with figures of different animals such as the humped bull, buffalo, bison and also with human deities, trees etc. Engraved also on this side are some inscriptions whose script—the Indus script—has not yet been deciphered. When it is deciphered these seals will become the most important link for us with the Harappān people. In the meanwhile, these seals are important to us from their manufacturing point of view. They tell us the techniques and the implements known and employed by the Harappāns in making them. And in this regard some of the unfinished seals in different stages of manufacture are still more revealing.

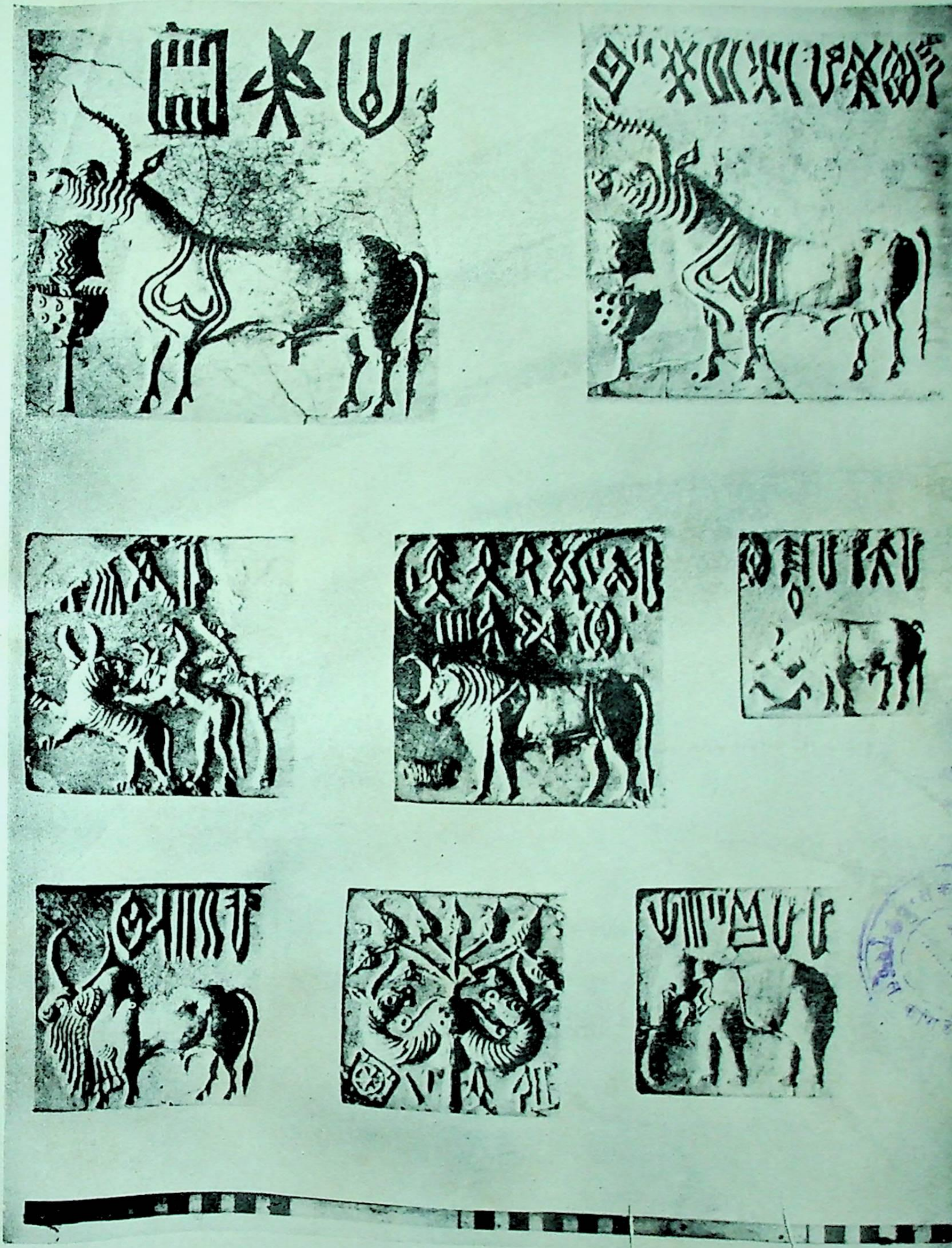
TECHNIQUE OF MANUFACTURE

Steatite seals seem to have gone through the following stages of manufacture.

(1) Cutting appropriate-sized piece from a block of steatite stone.

(2) Making a protuberance or a boss and a hole pierced through it on the reverse side.

(3) Engraving figures.



Harappā Seals

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(4) Engraving inscriptions.

(5) Finishing.

Cutting: Appropriate size of the stone seems to have been cut generally with a thin metallic saw 0.025 inch thick, as the marks on some of the unfinished seals indicate.

Making a Boss: On one of the surfaces of this piece of stone, again with the help of a saw, transverse cuts were made from each of the four sides which ended at an appropriate and equal distance from the centre. Vertical cuts were then made to do away with the redundant portions and to have a rough square projection on the back of the seal. This projection was then carefully rounded off with a knife, finish being given to it with an abrasive.

A hole was then bored through this boss which met in the centre from the opposite sides. This hole was not horizontal but slightly dipped towards the substance of the seal. This was cleverly done to avoid splitting of the steatite stone along the cleavage planes.

Engraving: The outline of the figures on the surface of the seal appear to have been engraved with the help of a burin. Further details as for example, the roughness of the hide of the rhinoceros etc., were created with the help of pointed and hollow drills.

The crookedness and congested nature of some of the inscriptions on the seals indicates that they were added later.

Finishing: This seal now otherwise ready, was sometimes treated, it looks, on the surface with the application of a thin coating of alkali and then it was fired so that it took on a white, hard and durable surface.

REFERENCES

1. *cited by* Marshall, J. 1931 Mohenjo-daro and Indus Civilization. London 3 vols.
2. Cunningham, J. 1878 Annual report of the Archaeological Survey of India VI, 1878.

3.	Marshall, J.	1931	*Op. cit*
4.	Marshall, J.	1931	*Op. cit*
5.	Vats, M.S.	1940	Excavations at Harappā. 2 vols. Published by Manager of Publications, Delhi. Printed by Manager Government of India Press, Calcutta.
6.	Wheeler, R.E.M.	1946	India's earliest civilization: recent excavations in the Indus Basin. Illustrated Lon. News, pp. 158-159.
7.	Wheeler, R.E.M.	1953	Harappā 1946: The defences & cemetery. Ancient India No. 3, pp. 58-130.
8.	Wheeler, R.E.M.	1953	The Indus Civilization (printed as a supplementary vol. to the Cambridge History of India) Cambridge University Press XI—98).
9.	Mackay, E.J.H.	1943	Chauno-daro excavations (1935-36). American Oriental series vol. 20. Amc. Oriet. Soc. New Haven, Connecticut. J.H. Furst Co., Baltimore, Maryland, U.S.A.
10.	Mackay, E.J.H.	1938	Further excavations at Mohenjo-daro vol. I, published by the Manager of Publications, Delhi. Printed by the Manager Government of India Press, New Delhi.
11.	Stein, A.	1929	An archaeological tour in Waziristān and northern Baluchistān. Memoirs of Arch. Survey of India No. 37.
12.	Vats, M.S.	1940	Excavations at Harappā, Calcutta.
13.	Vats, M.S.	1940	*Ibid.*
14.	Rao, S.R.	1964-65	Ind. Arch. Rev. p. 7.
15.	Marshall, J.	1931	Mohenjo-daro and the Indus Civilization. London.
16.	Wheeler, M.	1953	The Indus Civilization. Cambridge.
17.	Lal, B.B.	1962-63	A picture emerges. An assessment of C-14 datings of the proto-historic cultures of the Indo-Pakistani sub-continent. Ancient India No. 18-19, p.208.
18.	Fairservis, W.A. Jr.	1956	The chronology of the Harappān Civilization and the Aryan Invasions: recent archaeological research. Man. vol. LVI. No. 173.

19.	Subbarao, B.	1956	The Personality of India, M.S. Univ. Arch. Series No. 3. Baroda.
20.	Fairservis, W.A. Jr.	1956	Excavations in the Quetta Valley, West Pakistan. American Museum of Natural History.
21.	Wheeler, R.E.M.	1959	Early India and Pakistan. Lon. p. 113.
22.	Ghosh, A.	1954-55	Ind. Arch. Rev.
23.	Shastri, K.N.	1956	New light on the Indus Civilization vol. II. Atma Ram & Sons, Delhi-6.
24.	Sankarananda Swami	1946	The Rig Vedic Culture of the Prehistoric Indus, vol. I, Abheananda Acad. of Cul. 19B Raj Krishna St., Calcutta. Vol. IV Part I. History of Mohenjo-daro and Harappā.
25.	Ramchandran, T.N.	1956	Presidential address of the Ancient India Section at the All India History Congress held at Agra.
26.	Piggott, S.	1950	Prehistoric India. Pelican Books.
27.	Wheeler, R.E.M.	1959	Early India and Pakistan. London, p. 113.
28.	Mackay, E.J.H.	1943	Chauno-daro excavations, American Oriental series vol. 20. Boston, New Heaven, Connecticut.
29.	Rao, S.R.	1953-54	Ind. Arch. Rev. p. 7.
		1954-55	Ind. Arch. Rev. p. 59.
		1956-57	Ind. Arch. Rev. p. 80.
		1962-63	Ancient India No. 18-19, pp. 5-205.
30.	Lal, B.B., Bhola Nath, Ghosh, S.S. & Krishan Lal	1962-63	Excavations at Rangpur and other explorations in Gujarāt. Ancient India. No. 18 and 19, p. 5.
31.	*Cited in*	1960-61	Ind. Arch. Rev. p. 31.
31.a	Marshall, J.	1931	Mohenjo-daro and the Indus Civilization. London.
32.	Chowdhury, K.A. and Ghosh, S.S.	1951	Plant remains from Harappā. Ancient India No. 7.
33.	Encyclopaedia Britannica	1953	Vol. 18, p. 374.
34.	Beck, H.C.	1940	Report on selected beads from Harppā. pp. 392-398 *in* Excavations at Harappā by Vats, M.S. 1940.
35.	Forbes, R.J.	1950	Metallurgy in Antiquity E.J. Brill., Leiden.

36. Encyclopaedia Britannica 1953 Vol. 20, p. 229.
37. Rai, G.C. 1964 Studies in the development of Ornaments and Jewellery in Proto-historic India, p. 161. The Chowkhamba Sanskrit Series Office Varanasi-1.
38. Skinner, F.G. 1954 *In* History of Technology, vol. I p. 779 Ed. by Singer. C. et al, Oxford. Clarendon Press.
39. Hemmy, A.S. 1943 Weights at Chauno-daro, p. 236., *in* Chauno-daro excavations by Mackay E.J.H. 1943.

BIBLIOGRAPHY

Allchin, F.R.	1961	Utnur excavations, Andhra Pradesh Govt. Arch. Series No. 5, Hyderabad, pp 1-75.
Cottrell Leonard	1964	Lost Worlds, Published by Elek Books, All Saints St. London.
De cardi, Beatrice	1950	On the borders of Pakistan. Recent exploration, J. Roy. India. Pak and Ceylon Soc. Lon. Vol. 24 No. 2 pp. 52-57.
Fairservis, W.A. Jr.	1956	The Chronology of the Harappān Civilization and the Aryan invasions. Recent archaeological research. Man, Vol. LVI, No. 173.
Fairservis, W.A. Jr.	1961	The Harappān Civilization—New evidence and more theory. Amer. Museum Novitates, New York.
Ghosh, A.	1952	The Rājputanā Desert—Its archaeological aspect. Bul. National Instt. of Scs. India, No. 1, pp. 37-42.
Gordon, D.H.	1952	The early use of metals in India and Pakistan J. Roy. Anth. Instt., Vol. LXXX, pp. 55-58.
Gordon, D.H.	1958	The prehistoric background of Indian culture, Bombay.
Heine-Geldern, R.	1956	The coming of the Aryans and the end of the Harappān civilization. Man. Vol. 56 part 151, pp. 136-140.
Lal, B.B.	1954-55	Excavations at Hastinapur, Ancient India, No. 10, 11.
Lal, B.B.	1962	A new Indus Valley capital discovered. Excavations at Kalibangan in northern Rājasthān Illust. Lon., News, pp. 454-457.
Mackay, E.	1930	Further Links between ancient Sind, Sumer and elsewhere. Antiquity Vol. V, No. 20, pp. 459-73.
Mackay, E.	1937-38	Further excavations at Mohenjo-daro, New Delhi.

Mackay, E.	1943	Chauno-daro Excavations, American Oriental series, Vol. 20, Boston, New Haven, Connecticut.
Mackay, E.	1948	Early Indus Civilization, Luzac & Co., 2nd Ed., London.
Majumdar, N.G.	1934	Explorations in Sind. Memoirs Arch. Survey of India, No. 8, pp. xi-172.
Marshall, J.	1931	Mohenjo-daro and the Indus civilization, Vol. 3, London.
Mode Heinz	1961	The Harappā Culture and the West, Sanskrit College series No. XVI, Calcutta.
Piggott, S.	1946	The Chronology of Prehistoric North-west India. Ancient India No. 1, pp. 8-26.
Piggott, S.	1950	Prehistoric India, Pelican books.
Piggott, S.	1961	The dawn of civilization, Thames & Hudson, Lon.
Pusalkar, A.D.	1942	Indus Civilization. Bhar. Vidya Bhavan Vol. 3, pp. 140-159.
Raikes, R.L. and Dyson, R.M.	1961	The prehistoric climate of Baluchistān and the Indus Valley, Am. Anth., Vol. 63, No. 2 Part I, pp. 265-281.
Rao, S.R.	1956-57	The Excavations at Lothal, Lalit Kalā Nos. 3-4, pp. 82-89.
Rao, S.R.	1961	New light on the Indus valley Civilization ; seals, drains and a dockyard in new excavations at Lothal in India Part I, Ill. Lond. News, pp. 302-304.
Rao, S.R.	1961	Maturity and decline of the Indus Civilization : Religion and Industry revealed in excavations at Lothal, Part II, Illust. Lon. News, pp.387-389.
Sarkar, H.B.	1953	The Granaries at Harappā, Man in India, Vol. XXXIII, pp. 137-42.
Sarkar, H.B	1954	Artifacts of fishing and navigation from the Indus Valley, Vol. 34, Man in India, pp. 282-87.
Stein, A.	1904-5	Report on archaeological survey work N.W. Frontier and Baluchistān. Baluchistān Distt. Gazetter. Vol. 2, pp. 44-49, Allahabad.

Stein, A.	1929	An archaeological tour in Wazīristān and Northern Baluchistān. Memoirs Arch. Survey of India, No. 37.
Stein, A.	1934	The Indo-Iranian Borderlands; their prehistory in the light of geography and recent exploration, Man Vol. XXXIX, No. 16.
Stein, A.	1937	Archaeological reconnaisance in north-western India and south-eastern Iran. Lon.
Starr, R.F.S.	1941	Indus Valley Painted Pottery. Princeton Oriental texts, VIII, Princeton Univ. Press, pp. XIII-106.
Subbarao, B.	1958	The Personality of India 2nd ed., Baroda.
Vats, M.S.	1934-35	Rangpur excavations, Ann. report of the Arch. Survey of India.
Vats, M.S.	1940	Excavations at Harappā. Manager Govt. of India Press, Calcutta.
Wheeler, R.E.M.	1946	India's earliest civilization. Ill. Lon. News, pp. 158-159.
Wheeler, R.E.M.	1947	Harappā 1946, Ancient India No. 3, pp. 58-130.
Wheeler, R.E.M.	1953	The Indus Civilization. Suppl. vol. to Cambridge History of India. Cambridge Univ. Press.
Wheeler, R.E.M.	1959	Early India and Pakistan, London.
Zeuner, F.E.	1958	Dating the Past. 4th Ed., London.

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